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Local Variation in the African Elephant.

By R. LYDEKKER.

IN common with other species of big game whose range comprises the greater part of the continent south of the northern tropic, the African elephant displays marked local variation; such variations being apparent alike as regards bodily size and shape, the form and proportionate dimensions of the ears, and the length, calibre, and curvature of the tusks. As regards bodily size, adult males from East-Central Africa (as exemplified by specimens in the British and Royal Scottish Museums here figured) not uncommonly attain a height at the shoulder of 11 feet 3 or 4 inches; while an elephant from Wadelai is stated to have stood 11 feet 6 inches, and the stature of a specimen from Abyssinia has been given as 11 feet 8½ inches. That monsters may occasionally reach a dozen feet in height is, therefore, by no means improbable, although we have no definite record of such stature being attained; and, indeed, owing to the difficulty of taking measurements, records of large specimens are comparatively few. On the other hand, there seems little doubt that in some parts of the Congo territory there exists a relatively pigmy race of elephant, although as the only definitely known example was not adult when described, details on this point are not yet available.

The largest known tusk is one from East-Central Africa, in the collection of the British Museum, which weighs 238 lbs. and measures 10 feet 2 inches long. Its fellow is reported to have been of the same approximate dimensions. Of a pair of very fine tusks from the White Nile, described by Sir William Garstin in the *Field* newspaper of December 5, 1905, the one weighed 159½ lbs. and measured 7 feet 11 inches in length, while the weight of the other was 135½ lbs. and its length 8 feet 3 inches.

That tusks from different parts of Africa possess distinctive characteristics of their own is a fact well known to ivory merchants and brokers; and it would no doubt be possible to divide the species into local races upon this evidence. Tusks, at any rate with authenticated localities, are, however, by no means common in museums, and it has accordingly been found more convenient to take the ear as the basis for the definition of local races, although in one instance reliance has been placed for this purpose on skull-characters. In the *Zoological Society's Proceedings* for the present year the writer has attempted to classify by ear-characters such specimens of African elephants as were at the time available, and the editor has suggested to him that a summary of the results would be of interest to the readers of this journal. It is practically certain that the local varieties recognised in this communication by no means exhaust the list, and that there are other forms still to be identified.

An important feature in the ear of the species is the point or "lappet," formed by the lower extremity, which varies greatly in shape in the different races; but in addition to this, there is a large amount of local variation in regard to the contour of the ear as a whole, and, likewise, in respect to its relative size.

Fig. 1.—Head of the West African or South Cameruns Elephant. (From Heck, "Lebende Bilbe aus dem Reiche der Tiere.")

The four most diverse types of ear are respectively presented by the West African, or South Cameruns, race, in which this organ is nearly oval; by the Addo Bush, or East Cape, race, in which they present a squared form; by the Masai elephant, in which they are small and form an almost equilateral triangle; and by the Abyssinian, or Sudan, race, in which they are very large, and form a long and acutely pointed triangle.

Taking the various races according to their geographical distribution, we find that in the Addo Bush, or East Cape, elephant (*Elephas africanus capensis*), which now remains only in a protected condition near Port Elizabeth, the ears are rather small, somewhat square in shape, with rounded corners, and a small, sharply pointed angular lappet at the lower angle. The forehead falls away towards the temples, so as to appear highly arched; the fore-legs are relatively short, and the ventral line of the body is stated to be nearly straight, in place of highly convex. A very characteristic feature of this race is a comparatively abundant

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coat of hair on many parts of the body. The tusks, like those of the next race, are relatively small. In former days this elephant had, no doubt, an extensive

Fig. 2.—Head of the North-East Rhodesian Elephant in the British Museum.

range on the east side of the Cape, reaching at least as far north as the Orange River Colony.

Next comes the West Cape elephant (*E. a. toxotis*),

Fig. 3.—Part of head of the Aberdare Elephant in Mr. Rothschild's collection.

now existing only under protection in the Zitzikama Forest near Mossel Bay, in which the ears are much larger (4 feet 5 inches in a female 8 feet 8 inches high), long, and semi-oval in shape. In the Matabili or Mashonaland race (*E. a. selousi*) the ear is much less elliptical than in the West Cape elephant, and approaches more to that of the Cameruns race, although less completely oval. This race formerly inhabited all Matabililand and Mashonaland, and is represented by a mounted head in the Imperial Institute shot by Mr. Sligo Jameson, the companion of Mr. F. C. Selous. The tusks are of medium size.

Very distinct is the West African elephant (*E. a. cyclotis*), typically from South Cameruns, in which the ears are very large, but of quite different shape, the contour being a regular, short oval, and the lappet in the form of a half-ellipse. The skin presents a mosaic-like appearance, and its colour is of a paler grey than

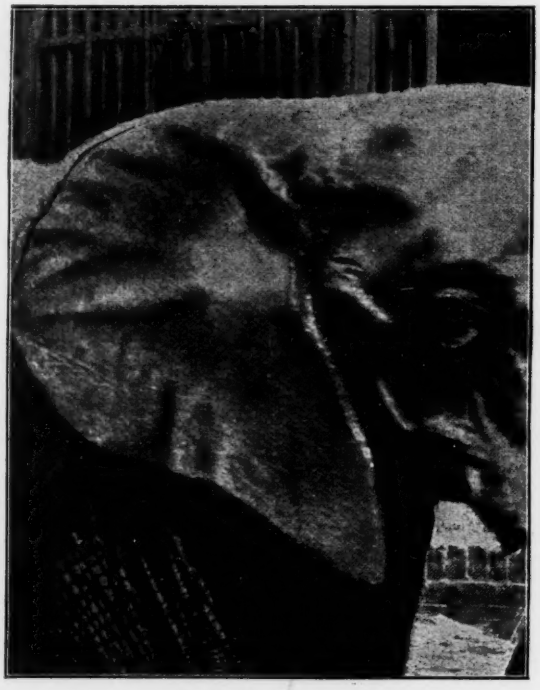

Fig. 4.—Part of the head of the Sudan Elephant. (From Heck, "Lebende Bilde aus dem Reiche der Tiere.")

in most other races. This race was named on the evidence of a young specimen in the Berlin Zoological Gardens, the ear of which is here shown (Fig. 1). The Congo elephant (*E. a. cottoni*) apparently comes very close to this type, but has the ear less regularly oval. Its tusks are very long and slender.

The Masai race (*E. a. knochenhaueri*), typically from German East Africa, is a very large elephant, with small, regularly triangular ears, in which the lappet is angulated and pointed. A mounted specimen in the British Museum (Fig. 2) from near Fort Manning, North-East Rhodesia, standing 11 feet 4 inches in height, with ears measuring 4 feet 2½ inches by 3 feet 5 inches, either belongs to this race or indicates a closely allied type. Although a male in the prime of life, that is to say, with the last molar tooth just come into use, it has relatively very small tusks.

In the Aberdare elephant (*E. a. peeli*), typically from the Aberdare Mountains, British East Africa, the ears are pear-shaped, with the lappet very long, although

somewhat rounded at the tip; and the tusks are very long and slender. The type specimen of this race is preserved in the private museum of Mr. C. V. A. Peel at Oxford, but an elephant's head from South-East Africa in the Hon. Walter Rothschild's museum at in the British Museum, the ears, inclusive of the fold, measure 4 feet 10 inches in depth by 2 feet 11 inches in breadth, and the tusks are of medium size. An elephant in the Royal Scottish Museum at Edinburgh, killed by Major Powell-Cotton in the Lado enclave,

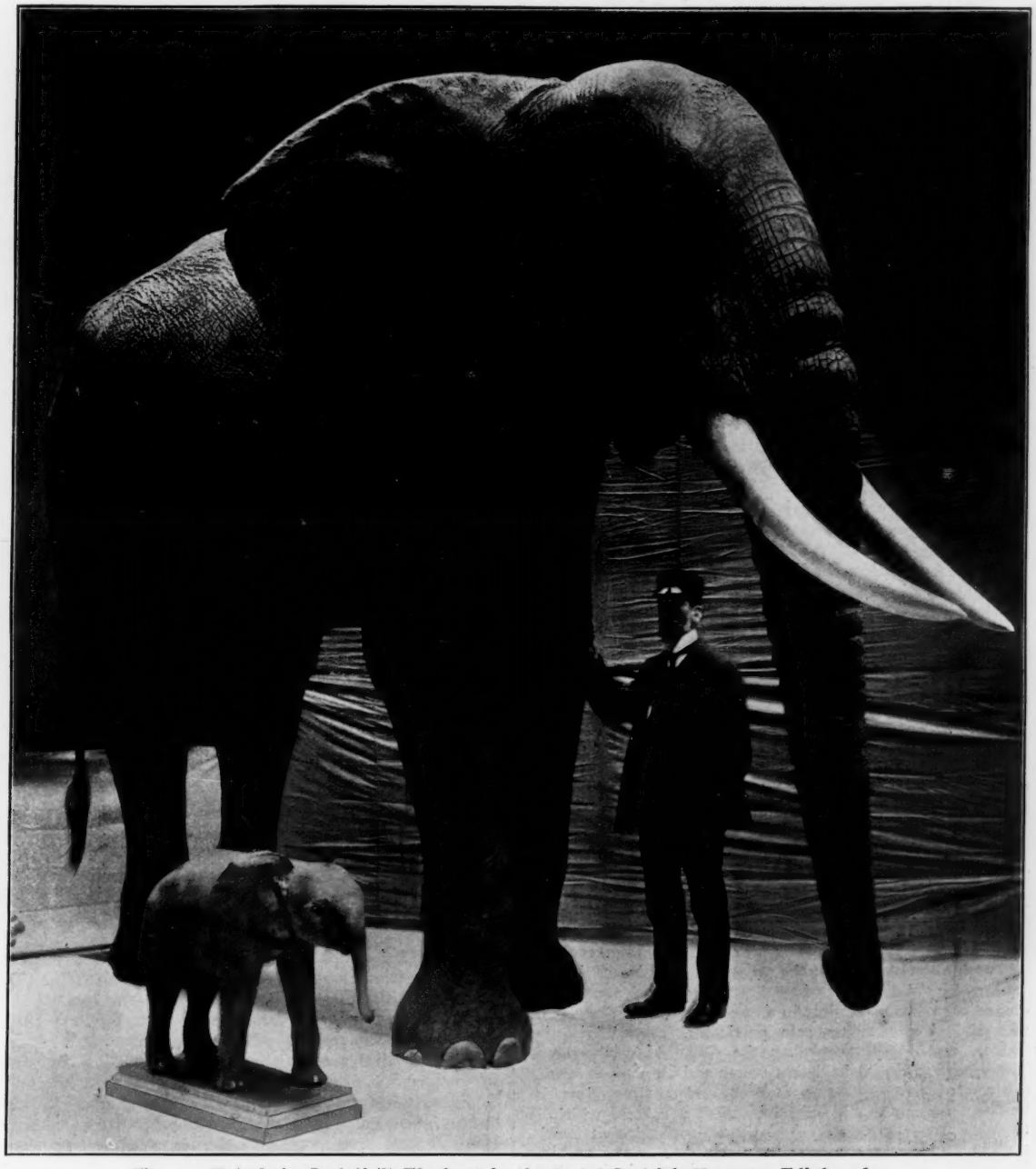

Fig. 5.—Male Lake Rudolf (?) Elephant in the Royal Scottish Museum, Edinburgh.
(Mounted by Rowland Ward, Ltd., of Piccadilly.)

Tring (Fig. 3) apparently belongs to the same type.

Somewhat further to the north-east we have the Lake Rudolf elephant (*E. a. cavendishi*), which is nearly allied to the last, but has broader ears, with a shorter lappet. In the type specimen, which was killed by Mr. H. S. H. Cavendish to the east of the Lake, and is about five degrees north of the equator, may be provisionally assigned to this race. The ears in this specimen, which is shown in Fig. 5, measure, exclusive of the fold, 4 feet 6 inches in depth, or practically the same as in the type.

The race most commonly seen in European

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menageries is the Abyssinian, or Sudan, elephant (*E. a. oxyotis*), in which the huge ears form an elongated triangle, with the upper border rounded and the lappet very sharply pointed and angular. This elephant attains very large dimensions; specimens of the ears (Fig. 4) measuring as much as 6 feet 5 inches in vertical diameter; the tusks do not attain the enormous length of those of the Aberdare and, perhaps, some other East-Central African elephants. The elephants of the Blue Nile belong to this race.

A remarkable contrast to the preceding is presented by the North Somali elephant (*E. a. orleansi*), which is a small race, with the upper border of the small ears straight, and the lappet short and distinctly defined. It is represented by a head in the collection of the Duke of Orleans at Wood Norton.

The last of the races named on the evidence of the ear is the West Sudan elephant (*E. a. rothschildi*), in which the ears are in some respects intermediate between those of the Abyssinian and those of the West African race, although approximating to the former in the shape of the lappet. It was represented by the well-known "Jumbo," formerly living in the London Zoological Gardens, and by "Sahib," of the Paris Gardens, both of which were imported at the same time. The race attains very large dimensions, but the tusks do not seem proportionately big.

In addition to the foregoing there is the above-mentioned dwarf elephant from the Congo (*E. a. pumilio*). The Albert Nyanza elephant has also been separated as *E. a. albertensis*, and is characterised by the unusually short and broad skull, which presents a resemblance to that of an extinct Indian species.

The author is indebted to Dr. Eagle Clarke for the photograph of the elephant in the museum at Edinburgh, and to Mr. Rothschild for that of the head at Tring. He desires also to express his indebtedness to Dr. Heck.

The Origin of Earthquakes.

PROFESSOR T. J. J. SEE, M.A., has contributed to the *Proceedings* of the American Philosophical Society, XLVI. (1907), a dissertation on the temperature, secular cooling and contraction of the earth, and on the theory of earthquakes held by the ancients. As this title indicates, the paper may be regarded as roughly divided into two parts. In the first, Professor See discusses the applications of Fourier's analysis to the problem of the cooling of the earth. His main conclusion would appear to be that the contraction of the earth's crust at the present time is insufficient to account for the existence of earthquakes and volcanoes. The second part consists mainly in a discussion of the theories of the ancient philosophers; in particular, Plato, Aristotle, Strabo, and Pliny, regarding the cause of earthquakes. These authorities all held that water and air penetrate into the earth through hollows, fissures, and crevices, thus developing vapour in the heated interior, a part of which is expelled from volcanoes. And they also held that earthquakes are due to the pressure of elastic vapours seeking to diffuse themselves into the atmosphere whether these vapours break through and form eruptions or remain hidden in the earth. Professor See's conclusions point to the general inference that these ancient theories are in their main substance in complete accord with the results of modern scientific investigation. Incidentally, reference is made to the scarcity of reliable translations of the Greek works referred to, and he specially instances Aristotle's treatise on meteorology.

Is There a Central Sun?

By PROF. F. TARRIDA DEL MARMOL, B.Sc., C.E.

THE problem of a central sun which would be the centre of our own solar system—a problem which has been so masterfully treated in these columns by Mr. F. W. Henkel—has for a long time occupied the minds not only of astronomers, but also of philosophers, and even of theologians, especially those who, for religious motives, are inclined to support the anthropocentric doctrines.

These doctrines find a strong support in the idea that the sun—as suggested by such an eminent man as Dr. Russell Wallace—turns round some centre which should be the centre of our "limited" universe. I think that the problem, considered under its mathematical aspect, can only be solved by the negative, unless we reject many facts which are almost universally admitted.

Which should be the centre of gravitation of our sun?

Whatever it is, our distance D to it must agree with the equation:

$$(1)\quad \frac{V^2D}{X}=C,$$

deduced from the Harmonical Keplerian Law, in which C will be the gravitation constant (which equals 6.6 by 10^{-8}, provided we express in centimetres the velocity, V, of the sun, its distance, D, from the central body, and we express in grammes the mass, X, of such central body).*

If our nearest star, Alpha Centauri, were our central sun, the formula (1) tells us that its mass X should be 200,000 times the mass of our sun; but we know that it is not so, as, this star being a double one, its mass has been estimated.

We can say the same respecting Sirius, whose mass X would then be 380,000 times that of the sun, while we know that it is only about six times.

We must also dismiss Vega, which, if it was the central sun of our sun, should be 1,000,000 times heavier than the latter, and should considerably outshine Sirius.

The giant Canopus, which has sometimes been suggested as this central sun, has not a known parallax, and its distance is unknown, but Sir David Gill has found an inferior limit to it, with the result that we know that the distance cannot be smaller than 290 "light-years," so its mass should be at least 16,000,000 times that of our sun.

We are led to dismiss the possibility of such a figure for many reasons, such as the strong probability that before reaching such a mass, a body would have attained the last phase of its evolution and transformed itself in nebula; and also the strong improbability that out of the total mass, calculated by Lord Kelvin, such a considerable part would be concentrated in one star. Besides, taking into account the masses and the distances, Canopus, if it were 16,000,000 times heavier than our sun, and, consequently, about 3,000,000 times heavier than Sirius, should considerably outshine that star, while the contrary is the case. Let us now consider, not Alcyone alone, but the whole Pleiades group, which many Continental astronomers believe to be the centre round which our sun turns, and amongst them my friend Baron Frederick Stackelberg, a learned

* The mass of the sun is about 2×10^{33} grammes, and its velocity $V=25\times10^5$ centimetres per second, according to L. Struve.

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Russian astronomer, who just recently wrote me expressing his firm belief in this theory.

The formula (1) tells us that the mass X of the whole Pleiades group, if it were this centre, should be 9,000,000 times that of our sun, assuming Alcyone, whose parallax is known, to be the centre of the Pleiadic system, and that this system constitutes a physical group.

Let us concede that two-thirds of the stars of such a group are dark ones and that only one-third are brilliant. Comparing, then, Sirius and the Pleiades group—taking into account the distances, the mass of Sirius, and only one-third of the mass of the Pleiades—we see that the light this group should send us ought probably to be 1,000 times greater than the light received from Sirius; so I strongly believe we must dismiss the idea of the possibility of the Pleiades being the gravitation centre of our sun. And, if we go further, our argument will be still more strengthened, because the greater the distance, the greater the mass of the central body will have to be.

So my conclusion is that all the evidence is against the theory of the sun describing a closed orbit in space, and that we ought to dismiss such hypothesis once and for ever.

Mercerised Cotton.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

FEW, perhaps, of those who have occasion to speak of mercerised cotton ever reflect that the term, which is now an every-day word, not only describes what is practically a new fibre, but also commemorates the name of its inventor.

For upwards of thirty years Mercer's discovery was little more than a failure, from a commercial point of view, and it was not until the necessary reagents had grown cheaper, and it had been shown by later inventors that the process could be made to produce a material closely resembling silk, that it became possible to manufacture fabrics of the treated cotton at a price that would enable them to hold their own in the market.

When that time came the roundabout description of "cotton treated by Mercer's process" soon gave place to the more concise "mercerised cotton," and the verb to "mercerise" forced its way into the English language in much the same way as the verb to "macadamise."

John Mercer, who has thus given us a new word as well as a new material, was born in 1791 at Great Harwood, in Lancashire, and died in 1866. His father owned one or two small spinning mills, and thus, from his earliest years, the boy was brought in touch with the methods of preparing fibres.

After leaving school he was apprenticed to a handloom weaver, and for several years worked steadily at that industry until he had saved enough out of his scanty earnings to commence business on his own account as a weaver and dyer.

A copy of *Parkinson's Chemical Pocket Book*, which chanced to fall into his hands, immediately suggested to him the possibility of applying the principles of chemistry to his own industry, and he lost no time in making experiments on improved methods of dyeing. So successful were some of his discoveries that he was offered and accepted a post at a small salary in the firm of Fort and Co., with the object of continuing his researches on dyeing, and this led eventually to his becoming a partner in the firm.

Important as were several of his discoveries in connection with dyestuffs, none of them has had the far-reaching effects of the results of his investigation of the action of caustic alkalies upon vegetable fibres. The patent in which Mercer described his discovery was taken out in 1850. It claimed the application of caustic potash, soda, and other substances as a means of improving cotton and linen fibres, and rendering them more suitable for dyeing.

Specimens of fabrics woven from the treated cotton were shown at the International Exhibition of 1851, and attracted much attention; but, notwithstanding this favourable start, the process soon fell into a commercial decline, mainly owing to the very high price of caustic soda, which at that time was not a common article of commerce.

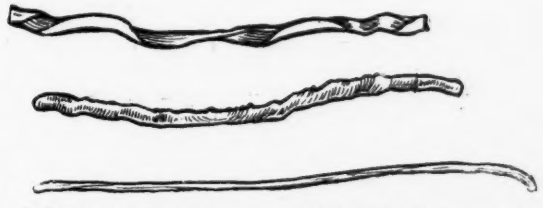
Hence by the year 1880 mercerised cotton was practically unobtainable, although by that time caustic alkali was sold at a relatively low price.

During the following three years several patents were taken out by MM. Garnier and Depoully, the underlying principle of which was the treatment of a fabric of mixed vegetable and animal fibre with alkali, with the result that the former was contracted while the latter remained unaltered, and a crêpe or "crumpled cloth," as they termed it, was produced. The formation of lustre on the fibres, which is now one of the chief aims of the process, was at that time looked upon as a disadvantage, and special efforts were made to prevent its appearing.

Not until 1890, in a patent of Lowe, do we find the production of a glossy appearance claimed as an advantage. The principle introduced in this patent—that of stretching the fibres in addition to the treatment with alkali—has now become an essential art of the mercerising process.

From that time onwards there has been a constant succession of patents, dealing mainly with improvements in machinery or with modifications of methods, but the fundamental principles of treatment of the fibre with alkali with the simultaneous or subsequent application of tension may be traced in most of the new processes.

The conditions under which the highest degree of lustre may be attained have also been thoroughly investigated and applied, so that at the present time the finest mercerised cotton has, superficially, all the appearance of silk.



1.—Ordinary cotton, × about 170. 2.—Cotton treated with caustic soda, × about 170. 3.—Cotton mercerised and stretched, × about 100.

The first effect of immersing cotton fibres in a solution of caustic soda is a shrinkage. The fibres lose their characteristic flattened, twisted form (see Fig. 1), and become more cylindrical (Fig. 2), assuming something of the appearance of linen, though without its characteristic transverse markings.

If the alkali solution be of the right strength and the correct immersion given, the fibres will be strengthened; but there are several factors in the different processes which tend towards weakness, with the result that

holes may appear mysteriously when a fabric made up from such weakened material is washed once or twice.

A primary object of mercerisation as carried out to-day is the production of the highest degree of lustre without undue weakening of the fibre, and for this purpose several points have to be observed in addition to the stretching of the cotton.

The nature of the yarn is an important factor, some cottons being naturally much more glossy than others. Thus Egyptian and Sea Island cottons are particularly suitable for mercerising, and their natural lustre is still further increased by combing and removal of the minute hairs on the surface by singeing or "gassing," as it is termed. In fact, years before Mercer's discovery, imitation silk was prepared from such glossy varieties of cotton by some such mechanical means.

After these preliminary processes the cotton is doubled or twisted together and treated with a bleaching agent, such as dilute caustic soda and sodium hypochlorite solution, for it has been found that a better lustre can be imparted to bleached than to unbleached fibres, although on this point authorities differ. Various other bleaching agents may be used, but some of these (sodium peroxide, for example) may cause great weakening of the cotton.

The bleached hanks are now carried on rollers through a bath of caustic alkali of the right strength and temperature. Caustic potash produces somewhat greater lustre than caustic soda, but not to a sufficient extent to compensate the increased cost. An addition of a small proportion of carbon bisulphide to the bath gives a very pronounced increase of lustre, but the time of immersion has to be regulated to a nicety. If it is too short the fibres are not sufficiently acted upon, while with too long an exposure they are rendered brittle, or even partially dissolved.

With regard to the tension, the usual method is to stretch the yarns before the alkali bath, and to keep them at a uniform length throughout the process. This does not give so high a lustre as methods in which the cotton is first treated with alkali and then stretched, but there is much less risk of injuring the fibres. Another method of improving the lustre is to stretch the yarns during the treatment with alkali, and to increase the tension during the subsequent washing.

In some factories pressure is employed to improve the gloss, a heavy roller being fixed above the upper roller carrying the hanks of cotton; but here, again, the fibres are liable to be injured if the pressure be too great. The final stage in the treatment is the removal of the alkali by thorough washing with water, and this also plays a very important part in the chemistry of the mercerising process. When the cotton is immersed in the caustic soda bath, combination takes place rapidly between the cellulose and the alkali with the formation of an alkali cellulose, and in the subsequent rinsing this is transformed into a cellulose hydrate, in which water may be represented as taking the place of the alkali hydroxide.

For the removal of the last traces of alkali the cotton may be dipped in water acidified with acetic acid, the excess of acid being afterwards eliminated by a last rinsing with water. The hanks are then dried, dyed to the required colour, and passed on to the weaver. It may be asserted that as a general rule articles of mercerised cotton are at least as strong as those made of untreated material, for as was mentioned above, the controlled action of alkali should strengthen the fibres. Yet there are so many factors which may prove sources of weakness that one or more of these may outweigh the strengthening factor. Each new modification which tends to increase the lustre of the cotton usually introduces at the same time a new influence tending to weaken the fibre, and it is necessary for the manufacturer to strike the mean of a fair lustre without undue injury to the cotton. Unfortunately this is not always done, strength being sometimes sacrificed to the popular demand for brilliance. And hence it not infrequently happens that articles which appeared to the buyer particularly cheap are shown by the practical test of the laundry to have really been excessively dear.

Telegraphy of Photographs.

Professor Korn's Method.

DURING the last month Professor Korn has installed his apparatus for telegraphing pictures over long distances, and we are indebted to the editor of the *Daily Mirror*, between whose London and Paris offices the system is in operation, for a copy of one of the first photographs transmitted. The principle of sending photographs over a telegraphic wire is based on the electrical conductivity of selenium, which varies according to the amount of light falling on it. The photograph which is to be transmitted is in the form of a transparent film wound round a revolving glass cylinder, and a powerful

light is concentrated through a tiny hole on the film. The light which passes through the glass cylinder is reflected on to the selenium cell, through which the telegraphic current is passing, and this current varies in strength according to the intensities of each consecutive element of the photograph. This constantly-changing electric current acts on a magnet at the receiving station. The magnet opens or closes the shutter according to the varying strengths of the current, and so exposes more or less of the film which is revolving behind it. The photograph which we reproduce was telegraphed from Paris in twelve minutes.

Stereoscopic Curves with the Twin-Elliptic Pendulum.

By CHARLES E. BENHAM.

IT is well known that the curves produced with the rectangular harmonograph may be made to show interesting effects of stereoscopic relief if a pair of them are described of identical size, but in slightly differing "phase." Both size and phase are easily brought under mechanical control, the former by ensuring that the pendulums are started at a prescribed amplitude, the latter by arranging for the release of one pendulum at the requisite interval after starting the other.

But with the twin-elliptic or any gimbal-mounted pendulum it is clear that neither size nor phase are readily brought under control. A figure cannot be repeated exactly, nor can the phase be minutely ensured, and for that reason it is generally assumed to be impossible to produce true stereoscopic effects with any form of harmonograph that combines elliptical movements.

Yet the problem is not an insoluble one, for by very simple means it is quite possible to produce with the twin-elliptic pendulum two figures identical in size and yet qualified with the slight difference in phase necessary to produce the very beautiful effect of a solid curve in the stereoscope.

In order to explain this simple method it is necessary first to point out that when a curve tracing is very nearly, but not absolutely, a harmony, a gradual change of phase is necessarily occurring throughout the process of describing the curve. This is obvious when it is considered that under such conditions the pendulums, not maintaining an exact ratio, gain progressively the one on the other; in other words, gradually change phase. It follows, therefore, that in an approximate harmony that portion of any line which is on the right-hand side of the figure will not be the exact counterpart of the corresponding portion on the left-hand side, but will form part of a curve of slightly modified phase. If a symmetrical figure, such as an approximate 1 : 3 harmony, is cut into halves, the two halves, though apparently corresponding line for line, are not exactly alike, and a close inspection will at once reveal the minute differences at the loops and corners due to the progressive change of phase that occurred as the curve was being traced. This difference, though slight, is

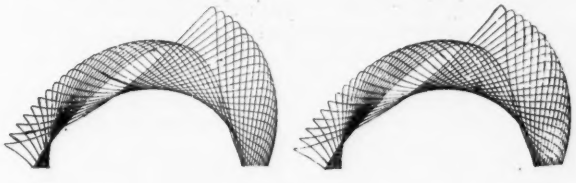


Fig. 1.

quite sufficient to produce a marked stereoscopic effect, and if the two halves are placed side by side and examined in the stereoscope it will be seen that they combine perfectly to form the single image of a solid curve. See Fig. 1.

This being understood, it will be easily realised that if, instead of bisecting the figure, two copies of it are made photographically, and one of them is *inverted*, a stereoscopic pair will be produced. The right-hand portion of one will combine in the stereoscope with what was originally the left-hand portion of the other. Unless one is inverted the effect in the stereoscope is,

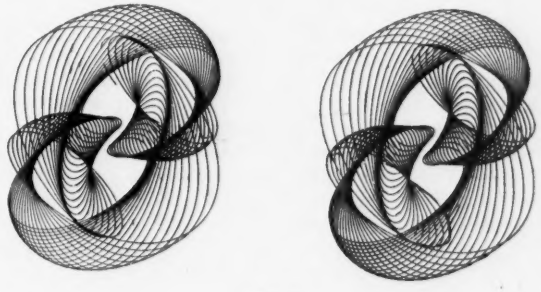


Fig. 2.

of course, perfectly flat, because the figures are then identical, but the inversion causes the superposition of two images every portion of each of which differs in phase from the approximately corresponding part of the other. (Fig. 2.)

The method is only applicable to symmetrical harmonies, that is, those which have an even number of nodes, so as to provide for there being correspondence when one of the figures is inverted. Unsymmetrical harmonies, having an uneven number of nodes, obviously cannot be treated in this way, because they are not composed of oppositely corresponding nodes and loops. The symmetrical harmonies are those compounded of a ratio the sum of which is an even number, such as 1 : 3, 3 : 5, 3 : 7, etc. The unsymmetrical figures have ratios the sum of which is an uneven number, such as 1 : 2, 1 : 4, 2 : 3, etc. The symmetrical harmonies among ratios of small numbers are comparatively few, but the variety of patterns of each ratio is very great.

The easiest way to produce the stereoscopic pairs is to trace the curve with a needle on smoked glass. The glass should be flooded with benzoline before being smoked, care being taken, of course, not to bring the benzoline bottle near the lamp. If the needle is firmly mounted in a wooden holder so that only an eighth of an inch projects it will travel very smoothly and noiselessly over the smoked surface, and will cut a fine, clear line. The tracing is fixed by flooding the plate with a thin fixative, such as methylated spirit five parts to one part of hard white varnish, or any good negative varnish will answer. When dry the plate can be used as a negative for photographic printing. A pair of prints is made and they are mounted at the proper stereoscopic distance, about $2\frac{1}{2}$ inches, one being inverted. Great care must be taken to mount them horizontally level. To insure this, lay the inverted print over the other and, holding the two in front of a strong lamp, adjust them until the two prints coincide as nearly as possible as seen through the paper, and, keeping them firmly in this position, cut the two out together by means of a sharp knife and a glass trimmer. The whole process is very easy to carry out, and the effects are so beautiful that no worker in curve tracery who cares to make the experiment will regret the trouble involved.

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Test Diatoms at Home.

By G. H. BRYAN, F.R.S.

IF any attempt were made to classify microscopic objects according to their popularity, there is little doubt that the valve of *Pleurosigma angulatum* would be placed at or very near the top of the list.

Nearly every owner of a microscope possesses a slide usually containing several hundred valves of this diatom, and many of us have wondered how these spread gatherings were obtained in such a perfect state of purity and freedom from foreign matter.

It is generally known that many diatoms, of which this species is one, can be more or less effectively separated from dirt by making use of their tendency to migrate towards the light. The experiment possesses many interesting features, and any microscopists who may be favourably situated for obtaining the diatoms would be well repaid by repeating the experiment themselves, even if they do not require to mount the diatoms afterwards.

In sunny weather the shores of the Menai Straits afford an excellent hunting ground for several species of Pleurosigma and other test diatoms. The place to look for them is on mud flats which are uncovered at low tide, but the surface of which remains wet. One may often visit such places without finding any very promising gatherings; when the diatoms are in the best state for collecting they form a thick brown film extending over the surface of the mud. A tin tobacco-box or a mussel-shell picked up on the shore forms a handy scraper by which as much as possible of the film should be collected with what mud clings to it, and transferred to a two-ounce wide-mouthed bottle; if the scrapings are insufficient to fill the bottle it should be filled up with sea water. On arriving home the diatoms and mud will be found to be shaken up together, and they should be transferred to a small dish, or saucer, or vaseline-tin about two or three inches in diameter and left over-night.

The next morning the mud will all have settled and will be covered with a brown film of diatoms. I next lay over the mud a piece of muslin or other material the meshes of which are sufficiently coarse to allow the diatoms to pass through. (This can be tested by examining the fabric through the microscope.) Even an old pocket-handkerchief will sometimes answer the purpose, particularly with the smaller species. As much as possible of the water is then drawn off so that the covering rests on the mud, leaving a very thin film of water just covering it, and the dish is placed in a bright light, not in the direct sunshine. Now comes the interesting part of the experiment.

If the weather is fine, with plenty of blue sky, a thick layer of diatoms will in the course of half-an-hour or so have risen to the upper side of the covering. To remove them I add a few drops of the water, and brush the diatoms to one side, at the same time slightly inclining the dish, and finally suck the material up with a pipette or the filler of a fountain pen, taking care not to draw up any dirt from beneath the covering. On examining the material under the microscope it will be found to consist of a seething mass of pure diatoms whose movements may be easily studied.

In another half-hour a second layer will have formed, and can be removed in the same way, and the process can be repeated pretty well half-hourly up till the middle of the day. If the first crop of diatoms contained any residual traces of dirt they will usually be completely absent from the subsequent crops. In the afternoon small worms and other animals find their way through the meshes of the covering, bringing dirt with them, the majority of the diatoms disappear, many of them being doubtless eaten, and those that are left are not in a fit state for mounting. Even if no diatoms have been removed in the morning the same thing takes place to a greater or less degree. The only thing to be done if more diatoms are wanted is to remove the muslin, carefully brushing the diatoms off it as far as possible, to add water and to wait till the next morning, when the muslin can be replaced and fresh crops obtained.

This photograph shows a group of diatoms from the mud of the Menai Straits after growing on muslin, taken with a low-power objective. The gathering consists mainly of *Surirella gemma*. The long dark diatom near the centre is *Pleurosigma balticum*, the lozenge-shaped valve at its side is *Pleurosigma angulatum*, the dark narrow S-shaped diatoms scattered about the group here and there are *Pleurosigma littoralis*.

In this neighbourhood the gatherings most frequently obtained consist of a mixture of *Pleurosigma angulatum* and *P. aestuarii*, but pure gatherings of *P. angulatum* or *P. quadratum* (usually described as a variety of *angulatum*) are nearly as common. In slightly different places *Surirella gemma* and *Amphiprora alata* can be obtained by the same method. It answers very well for freshwater forms also; I have used it with success in cleaning *Pleurosigma acuminatum*. During the South African visit of the British Association I obtained a very small quantity of a gathering of a *Cymbella* from the mangrove swamps on the shore at Beira, which I separated in the same way, using this time a little vaseline-tin about one inch in diameter. The results were perfectly satisfactory, though the cleaned material was only sufficient for two well-spread slides.

But the next interesting point is that different species

behave differently in several respects. When a mixture of *P. angulatum* and *aestuarii* is worked for two or more days, the later gatherings appear to contain a larger proportion of *angulatum* than the earlier ones. Again *P. quadratum* seems to retain its vitality longer than either of these species. Whether the slight concentration of the salt due to evaporation has any influence I do not know; the dish was, however, kept covered with glass in every case. I find that *Surirella gemma* is much slower in coming through the muslin, and does better with a rather thicker layer of water to grow in, but when it has come through it increases and multiplies well, and it can be obtained in good condition for mounting at a time in the afternoon when the method has failed to give satisfactory results with the Pleurosigmas.

Into the methods of cleaning for mounting purposes it would be unnecessary to enter here. I have used nitric acid with a tiny crystal of chromate of potash added near the end of the boiling (this greatly improves the result); also the "sulphuric and chlorate" method, and a large amount of washing is necessary in either case, particularly if the diatoms are to be mounted dry. By being rather wasteful of diatoms and drawing off the washings while still turbid a large proportion of the "girdles" can be removed, and the slides then present a less "jumbled up" appearance, approaching more closely to the professional standard.

But however careful one may be to use distilled water in the washings and to clean the cover-glasses, the difficulty of spreading the diatoms evenly when clean is great. Owing to capillary attraction the drop will persist in tearing away from the edges of the cover-glass, leaving lines of incrustation at every place where its edge rests. The plan I find answer best is to deposit sufficient water to make a fairly convex drop extending to the edges of the cover, with enough diatoms to make a closely-spread slide, and to heat the cover till tiny bubbles *just* begin to form. As the drop evaporates a slight incrustation forms round the margin, which keeps the surface film stretched out to the edge of the cover. When the drop has got so thin that the bubbles burst, I increase the heat further, and in the last stages of evaporation the diatoms themselves act as supports for the film, which is in a state of surface tension. There is thus no tearing away, and any incrustation is deposited round the edges of the cover. This latter I finally remove by cleaning away a ring round the edge with a handkerchief. The last operation, moreover, reduces the risk of moisture getting under the cover if the diatoms are mounted in styrax. Even if carbolised water is used for spreading the diatoms the centre of the cover-glass, and, indeed, all but the very edge, is quite free from incrustation.

Answers to Correspondents.

Orientation of Daniel's Comet.—It is usual to present astronomical photographs of objects which require telescopic power for their delineation just as they appear in the telescope, *i.e.*, inverted. Any comparisons with the view presented in an opera-glass or other erecting apparatus must, therefore, take account of this reversal.

Know (Dorchester).—Plates of the moon, size about 10 inches by 9 inches, have appeared in "KNOWLEDGE" from time to time, and can be had from the Office, price 2d. each.

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Autochrome Plates. These plates are still absorbing a great deal of attention, and the continued working with them is bringing to light their characteristics, some of which are advantageous and some otherwise. Whatever may be said about them it should be understood that in competent hands they yield excellent results with ordinary subjects, and they have been shown to be useful in photo-micrography and for natural history subjects. Mr. Martin Duncan has exhibited some very good results in photographing moths and butterflies with exposures of about eight seconds in bright sunlight. If the plates fail under more critical circumstances, such as in the photography of spectra, it is no more than might be expected, because the three-colour method is itself no more than a compromise at the best, and the conditions under which it is worked in these plates are not the most advantageous in more ways than one. On the other hand, the balance of colours, and the adjustment of the sensitive film, the colours of the dyes used, and the yellow screen that is fixed to the lens, are all arranged by the manufacturer with considerable skill, and done, so far as the user of the plates is concerned, once for all. Thus the opportunity for errors on the part of the photographer is greatly restricted.

At the same time much care has to be given to the working of them. The range of suitable exposure in any one case is very limited, and this is so not merely, if at all, because of the thinness of the sensitive film, though this would restrict the possible range if other circumstances did not obtrude themselves. I showed some few years ago that, other things being equal, red light generally gives a steeper gradation than green, and green than blue on photographic plates, whether colour sensitised or not. This phenomenon of the relationship between wave-length and gradation is shown in the autochrome plates. With a little over-exposure the red produces too much effect and a reddish tinge predominates, and with under-exposure the blue is in excess. These colour errors are chiefly noticeable in the whites and lighter tints. This increase of steepness of gradation as the wave-length increases is a matter that emulsion makers might endeavour to overcome, for from the results of my investigations I am not at all convinced that the difficulty need be dismissed as inevitable. It must not, however, be taken for granted that a predominance of either colour indicates an error in the duration of the exposure, because a little exposure to ordinary light, as, for example, if any light gains access to the plate that has not passed through the yellow screen that is attached to the lens, will cause a fog of blue on account of the excessive sensitiveness of the plate to blue, which, as with other plates, makes a yellow screen necessary. Or if the plate is exposed unduly to the dark room light in such a way that the light passes first through the glass and the layer of coloured granules, the red light will impart a reddish colour to the whole image.

Time Development. I have always considered that the success of the various methods of time development may depend largely upon the fact that under the conditions that generally hold at the present time the best negatives are often made by complete development.

XUM

That is, by developing until all the silver salt that has been affected by the exposure is reduced to the metallic state, or until development ceases to produce any further effect. If, then, the time specified is sufficient to allow of complete development, it does not matter at all how much longer, within reason, the plate remains in the developer. During the recent autumn I have tested this idea on nearly seven dozen plates of five distinct kinds and by three different makers. They included one sample of ordinary plates, three different kinds of isochromatic plates (sensitised for green), and one sample of panchromatic plates. The rapidities of the plates were from 78 to 111 Wynne, and the exposures given from one second to the one hundredth of a second (tested times) as indicated necessary by the use of an exposure meter. The subjects were very various, but all out of doors. Some of the plates were developed with metol and some with "Pushaxe" developer mixed as prescribed by the makers. Complete development probably took place in from four to six minutes, but the plates were allowed to remain in the developer for at least ten and more often for fifteen minutes to ensure that the development was carried to its utmost. There are only two of these negatives that might have been better if they had been developed for a shorter time. This, therefore, emphatically tends to confirm the notion that the chief reason for success in development by time instead of inspection is that it does away with the temptation to unduly curtail development, and that over-development is often impossible. The plates used for the above experiment were not specially selected for it, but were just such as would generally be employed in hand camera work. But there certainly are plates, especially those of the slower kinds, that may easily be over-developed if they are properly exposed, and such plates and films are not so suitable for time development methods. We may push the matter a little further and say that to develop a set of lantern slides from different negatives by any other method than a careful inspection of the growing image would be to court failure.

Exposure in Bromide Enlarging.

There must, practically speaking, always be a need to estimate the best exposure in bromide printing by some method of trial and error. The method that is generally advised is to make a series of varying exposures on a comparatively small strip of the paper and to judge on development which exposure is the best. Some makers supply trial strips for the purpose. This may be a satisfactory way to work if the detail all over the subject is of the same kind, as, for example, in a simple black and white subject like an engraving, but it fails altogether when dealing with many photographs of solid objects such as landscapes, portraits, views of machinery, photo-micrographs, &c. It fails because it is impossible to make the best by development of each one of a series of different exposures, developing them all in the same way and for the same time, and also because each exposure deals with a different part of the subject and only one, perhaps, with the most important part. It is far preferable to make the trials on pieces of paper large enough to include sufficient of the subject to form a real guide to the result, to expose each piece on the same part of the subject, and to develop each piece separately, so that the best may be made of it without reference to any other piece. Such trial pieces can be properly compared because they are really comparable. I find that it is not often necessary to use more than two trial pieces on the same negative. If one enlargement is required from each of a number of negatives it will be found economical to cut up two sheets of a dozen into four, six, or eight trial pieces according to the character of the subject. I generally cut the sheets into quarters, and cut a quarter in half only for those cases in which the smaller piece will include enough of the subject to form a reliable guide.

CORRESPONDENCE.

Beaded Lightning.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Dr. Lockyer, in his valuable series of contributions to this journal on lightning, has, in the last June and July numbers, argued for the unreality of what has been called "beaded" lightning. The numerous visual observations recorded by different observers, and several descriptions of which he has quoted in his paper, he makes out to refer to the afterglow and not to the actual lightning discharge. One of the illustrations he has given in the July number shows the afterglow on a plate taken with a moving camera as a series of trails. There could be no doubt that the bends in an ordinary meandering discharge are generally of greater brightness than the rest, and are shown in several photographs of mine taken without any moving camera. It is possible that the afterglow of these parts continues longer, but what is not quite certain, is that the eye, which has been impressed with both the flash and the afterglow, should be sensitive only to the latter in preference to the more vivid discharge as a whole. Further, if that should really be the case, the phenomenon should be of more frequent occurrence, considering that the meandering flash of this kind is very common. That so many observers, and some of them scientific men, should have observed and noted this form of lightning as peculiar and rare makes it improbable that they refer to the afterglow, which certainly accompanies most of the ordinary discharges.

The absence of good photographs of this class of lightning should primarily be due to their infrequent occurrence. Dr. Lockyer has explained away the alleged photographs of beaded lightning by Herr Van der Valk, published in Meteorologische Zeitschrift, on the theory of an artificial light source in front of a shaking hand-camera. They are, no doubt, very like the traces produced by an arc lamp of alternating current. I, however, rest my contention for the reality of the beaded form of lightning mostly on a photograph I took last April. The negative is not a very good one as I used only old plates for the purpose, but still, the beads are quite distinct, and I expect they would

not be lost in the reproduction. It will be noticed that the description of the visual observers with regard to the wavy form and the absence of branches is borne out, but that the flash is not, however, broken into consecutive dots along its whole length nor are the intervals between the bright points the same throughout. It may be that this form is intermediate between the absolutely "chapletted" variety and the ordinary lightning, or that the observers have only caught the impression of the bright points, losing sight of the less vivid connection between them. The difference between the photograph and the drawings of Messrs. Joule and Eudemans are no doubt very great, and it is presumed that the latter are not of the same kind as artists' lightning sketches of old. Still, the underlying beaded nature is the most important thing, and this the photograph shows along with the drawings.

The exposure was made on a stand camera directed towards a thunder cloud, and there could have been no movement whatever at the time of exposure. No artificial light was in front of the camera, and as for any electric installation, there is none nearer than a couple of hundred miles away.

G. NAGARJA.

Kodaikanal, India.

[I am afraid I cannot agree with Mr. Nagarja that the photograph which accompanies his note, and which has kindly been submitted to me by the editors of this journal at his request, represents an impression of beaded lightning. A careful examination of the flashes indicates first that the "beads" occur at points along the flash where the paths are most curved, and second that the flashes themselves are not in good focus. With regard to the first point it may be stated that this is a very common feature in flashes which "meander," and more especially so when the flashes are moving in some parts of their paths towards or away from the observer. In fact, in such cases the images of these portions of the flashes fall for a longer time on a restricted part

The trail of the Moon taken with a moving camera, showing the "beaded" appearance at the nodal points.

of the photographic plate, and the density on development is, therefore, very much stronger at these points. With regard to the second item, that is, the flashes are not quite in focus, the fact helps to intensify the beaded nature of parts of the flashes. Each point of light becomes a small disc when the camera is not in good focus, and the superposition of a series of these discs at the nodal points gives rise to a pronounced "bead."

Some time ago I was shown a photograph of a flash of lightning which the photographer termed "rope" lightning. It was something after the style of Mr. Nagarja's photograph, only more out of focus. The whole length of the flash was made up of a series of overlapping discs, and where the flash curved the discs were naturally closer together. It was my impression that the "out of focus" explanation was quite sufficient to account for all the peculiarities.

In order to reproduce such an effect, failing a convenient thunderstorm, I photographed the trail of the three-quarter full moon, keeping the camera fixed for 20 minutes. It happened that the planet Jupiter was in close proximity to the moon, so his trail was recorded as well. Before the camera was capped it was taken up and moved about in such a way that the image of the moon was made to trail over the plate. The resulting photograph is shown in the accompanying illustration, and the trail produced by moving the camera resembled the flash described as "rope" lightning to a very considerable degree of accuracy, with the exception, of course, of the shape of the path. On the present occasion it will serve to show how at the nodal points the discs appear intensified, and why they may be taken to be described as "beads," when applied to an out-of-focus image of a lightning flash.

I think this explanation is quite sufficient to account for the peculiarities in the photograph submitted by Mr. Nagarja rendering it unnecessary to class it as a "beaded discharge."

WILLIAM J. S. LOCKYER.]

London, S.W.

Rotation of Mercury and Venus.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Referring to the critique of that part of Father Selley's work which deals with the inner planets, may I point out to your reviewer that evidence of rotation, which is deservedly final for the observer and for those who like Father Selley do him the honour of believing his statements, cannot be forced on an unwilling public; this can only be accomplished by a rigorous determination of the planet's rotation elements, rendering possible the construction of an ephemeris. In an undertaking that in the case of Mercury is extremely difficult, and that has baffled the civilized world for more than a century, the investigator who has success almost, perhaps altogether, within his grasp would not be justified in making premature disclosures pending careful verification of his results.

May I also point out that the seeing of the faint shadings on Venus and even some of those on Jupiter, presents difficulties of a different order from that of seeing the canals of Mars or the details of Saturn? The high powers admissible in the latter case will not do in the former, and the observer with the great telescope is confronted with the problem of dealing with a flood of light that if concentrated on a small area of the retina will blot out delicate detail. This may explain in some measure the success of Cassini, corroborated by Schroter and De Vico, in the nineteenth century, and by Hansky and Stefanik in the twentieth, and the failure of Schiaparelli; for tranquil atmospheric processes surely never take place on a planet one-half of which is eternally roasted, and the other half frozen.

JOHN McHARG, M.A.

Lisburn.

[It appears to us that Mr. McHarg's letter is rather beside the mark. We have given him a notice, to which, on his own showing, he was hardly entitled, but we have *not* criticised, much less contradicted, him, nor are we responsible for Father Selley's "premature disclosures." Mr. McHarg's views on such controversial subjects as the limitations of great telescopes and speculative planetary meteorology do not concern

THE REVIEWER.]

The Collection of Rare Birds.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Some sportsmen in Norfolk, as I learn by your last issue, succeeded in killing several spotted Redshanks. I am very fond of shooting grouse, rabbits, and other animals which are abundant and require some skill to kill, but why people who have guns persist in killing pretty, harmless, and rare birds, which will, therefore, soon be extinguished and seen no more, I cannot conceive, and I hope you will implore them to allow such birds to live and multiply in our land and resist the momentary gratification of killing them.

J. L.

Dublin.

XUM

Spiritual (?) Photography.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I do not know if photographers are, as a rule, acquainted with a rather important fact, that they should, if possible, avoid using old plates re-cleaned and sold as new; but the following facts may interest them.

In the issue of the *Illustrated London News* for August 17 last there appeared nine photographs by Dr. Baraduc, who is under the impression that he can photograph, not spirits, but spiritual phenomena, such as dreams, prayers, and thoughts. One of the nine is described as a "Nightmare." However, they admit of a very simple and concrete interpretation, being merely the effects on old plates reproduced.

Some years ago, "spirit photographs" were published in Mr. W. T. Stead's "Borderland." On noticing a *word* and a *number* on one, I suggested that the plates were probably old ones; for it is well known that an engraving may be naturally "etched" on the glass of the frame covering it. My suggestion soon afterwards was shown to be right in a communication from America. No more spirit photographs were published. On examining the nine photographs in the *Illustrated London News*, and numbering them, anyone wishing to examine them can do so.

No. 1.—Some chemical decomposition has apparently produced the grey patches; but at the bottom it has suddenly stopped in a *circular manner*, possibly by a round piece of paper having been on the glass.

No. 2.—This has a word (in black) nearly obliterated, close to the bottom, with another word (white), in the right-hand corner. The curved illustration would very well answer for a spike of some liliaceous plant, the dots being in the usual spiral lines.

No. 3.—This has some writing at the left-hand side, near the bottom.

No. 4.—This has a black band down each side, where strips of paper were probably pasted on the glass.

No. 5.—This, like Nos. 1, 4, 8, and 9, has the decomposition starting at numerous points, often spreading one to another.

No. 6.—This appears to have been well rubbed by the cleaner in a circular manner, giving rise to what looks like a spiral nebula. It has writing at the right-hand top corner.

No. 8.—This has writing between two black lines in the upper left-hand corner.

If Dr. Baraduc will try again with glasses *straight from the manufacturer*, and never used before, I strongly suspect he will get no more "spiritual" images!

GEORGE HENSLOW.

Leamington.

The Moon's Colour.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—The letter from Mr. W. E. Crowther relating to the whiteness of the moon seen during daylight is very interesting. I have several times noticed the absence of colour referred to. It is usually most evident on a bright, breezy morning, when the waning moon is visible between the fast-flying clouds. At such times the atmosphere is very clear, whereas in the late evening there is often a tendency to mistiness. The moon has always appeared nearly colourless to me at night, provided the atmospheric conditions are unusually good. Quite apart from all considerations of atmospheric absorption, however, the moon, when visible under the circumstances Mr. Crowther describes, is seen through the entire thickness of an atmosphere which is diffusing the blue rays of the solar beams. The upper air, by reason of the dust particles contained in it, effects a very definite diffusion of rays of short wavelength while allowing the others to pass freely through it. It has occurred to me that, although the light emanating from that portion of the atmosphere which extends directly in the line of sight between the observer and the moon cannot, of course, contribute to form an image of our satellite, it may, nevertheless, modify the colour effect by conveying to the eye rays which are deficient in the moon-beams themselves.

CHARLES W. RAFFETY.

Purley.

Dew Ponds.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—As a reader of "KNOWLEDGE," I have been greatly interested in the articles on Dew Ponds. In my library there is a copy of "Herbert's Travels," wherein is detailed the journey begun by him in 1626. On page 4 will be found: "Hiero, or Ferram, appeared very high land as we paſt by it, and bears S.S.W., from Grand Canaria. Gomera is 6 leagues from Teneriffa, and above 8 leagues long; Palma is about 12 leagues from Gomera, and in circuit towards 20 leagues. Hiero is 10 leagues from La Palma, and not above 6 leagues in compaſs. Famous is Hiero in one tree (for it has but one ſuch), which (like the miraculous Rock in the Defart) affords freſh water to all the inhabitants. The Natives call this tree Garro; Santo, the Spaniard. Some part of the Day 'tis darkned with a cloudy miſt, which caſts a Dew upon the Leaves that diſtills in clear ſweet drops, ſtreaming into two large Stone Ciſterns, capable for the neceſſary uſe, not only of the people, but of all the Cattel in that Iſland. Sylveſter gives it this true and vive deſcription.

> In the Iſle of Iron (one of thoſe fame ſeven
> Whereto our Elders Happy name have given)
> The ſavage People never drink the Streams
> Of Wells and Rivers, as in other Realms.
> Their Drink is in the Air! their guſhing Spring,
> A weeping Tree out of itſelf doth wring,
> A Tree whoſe tender bearded Root being ſpread
> In dryeſt Sand, his ſweating Leaf doth ſhed
> A moſt ſweet Liquor; and (like as the Vine,
> Untimely cut, weeps (at her wound) the Wine
> Inpearled tears) inceſſantly diſtills
> A royal Stream, which all their Ciſterns fills
> Throughout the Iſland; for all hither hye,
> And all their Veſſels cannot draw it dry!

Which is very rare; Howbeit in Saint Thoma an Iſle under the Line, moſt of the Trees there have the like property."

Many times in the past I have referred in a credulous manner to this as an instance of where our ancesters dealt and gloried in mysteries, but since reading your article I have come to the conclusion that I have wronged Sir Thomas Herbert, and that what he referred to was but another evidence to confirm the reality of Dew Ponds.

Yours, etc.

M. G. MERRITT.

Rome, New York.

Meteors.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—On the evening of October 31, at 6.40 p.m., I saw a meteor of great brightness and somewhat unusual character. It commenced its course about midway between Altair (Aquila) and Vega (Lyra), and passed down almost to the horizon into Hercules. The trail left was unusually bright, and remained visible during the whole course of the meteor. When about four-fifths of its course, the meteor divided into two parts, and till its disappearance continued as two meteors. I have not observed this division previously, and it would be interesting to hear whether other readers made a similar observation.

Yours, etc.,

RICHARD WATTS WHITE.

Swavesey.

Practical Aerodynamics and the Theory of Aeroplanes.

By MAJOR B. BADEN-POWELL.

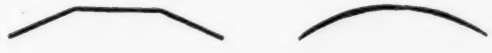
X.—COMPOUND PLANES AND AËROCURVES.

WHEN two planes meet at an angle, effects are produced that are of a rather complicated nature. Let two oppositely inclined planes, AB and BC, be joined, and exposed to a horizontal air current. We know that the air flowing up a slope like AB will have a tendency to continue to flow in the same direction after it has left

the surface. We also know that the current on the under-surface will eddy round and flow forwards. We may assume, therefore, that the stream lines would prove to be somewhat as in the diagram. The resultant effect would be that AB is pressed down on the upper side, and driven forward and downward on the under side. BC has a partial vacuum created above it, with a normal upward pressure, at all events on the back end of its under side. The general tendency would then be for the plane to turn over forwards. And this is just what happens in practice.

If a horizontal plane be interposed between the two, the result is less pronounced.

But the combination of planes at varying angles of inclination is nearly equivalent to a curved surface.



The reactions of air pressures on curved surfaces have been but little studied.

It is well-known that a surface with a concavity below will fall slower through the air than a flat one. With parachutes it is reckoned that if the depth be one-third of the diameter, the resistance to the air in falling will be double that on a flat plane of equal diameter. It can be shown by means of a basin in a current of air that when placed vertically the concavity causes the air close to the inner surface to flow outwards towards the edges.

If the basin be inclined to the current, the air in the leading portion of the concavity flows forwards, while that in the afterpart, of course, flows out behind.

Hargrave (*Aëronautical Journal*, October, 1897, and April, 1898), perhaps, first pointed out this reverse flow in a concave surface. He arranged a curved surface with a section supposed to be that of a bird's wing, as in the diagram, and tested the direction of the current by a candle flame, and by feathers, &c.

But, once again, we have to consider what goes on on the other side of the surface. The air impinging on the front curved surface will be deflected upwards, and a partial vacuum formed above the centre and rear part of the surface, which causes a tendency to lift vertically.

Lilienthal laid great stress on the practical efficiency of "aërocurves," or surfaces concave below and convex above.

But such surfaces, as we have seen, have a tendency to turn over forwards when projected in a horizontal direction, and more complicated curves are required to counteract this tendency.

Dr. Thomas Young, in 1800 suspended various surfaces by a thread in a current of air, and found that an S-like curve advanced against the jet of air. Other experimenters, including Hargrave and Turnbull*, have also found such a shape, that is to say, a surface curved downwards in front and upwards behind, to give good lift with little drift.

Mr. Turnbull conducted a series of experiments in Canada, placing five different forms of surfaces before a current of air. These were in section I.——, II. ⌣, III. ⌒, IV. ⌒, V. ⌒. He measured the lift, the drift, and the centre of pressure of each, and the general conclusion come to was that "Type IV. is the only aëroplane having at the same time automatic longitudinal stability combined with excellent lifting properties and exceedingly small drifting properties."

Other experiments with jets of air impinging on curved surfaces have shown unaccountable results, and there is great call for a careful series of investigations in this matter.

The Descent of the "Mammoth."

IN the account of the descent of the "Mammoth" balloon in our last number, a palpable mistake was made, when it was stated that the balloon dropped 11,000 feet in half a minute. This statement was presumably made without being intended to be scientifically exact, the times not having been accurately noted by stop-watch.

It may be interesting to consider what rate of fall is probable under the circumstances.

Take the total weight of the balloon, men, and all appurtenances. This could not have been much over 4,000 pounds, probably less. The balloon itself was 59 feet in diameter.

First, let us suppose the under side of the balloon to be hemispherical. The resistance it would offer to the air would then be at least one-third of its sectional area. This would be one-third of 2,700, or 900 square feet. But the balloon was not full, else it would not fall. Suppose, now, it was three-quarters full, then it would support 3,000 pounds. That is, it would fall with a velocity acquired from a pressure of about 1,000 pounds on 900 square feet.

If the neck line were released, the balloon would cave in at the bottom and form a parachute (as it is said to have actually done). This would retard the rate of fall. If the balloon were only half full of gas it would form a hemisphere with a flat under-surface of some 2,700 square feet. It would then support half the weight, so that the fall would result from a pressure of 2,000 pounds on 2,700 square feet, or slower than before.

It therefore seems unlikely that the pressure on the under-surface could be much more than one pound per square foot, which implies a speed of, at most, 27 feet per second. This is a pretty rapid rate to fall, but it means that the balloon would take about 400 seconds, or nearly 7 minutes to descend 11,000 feet. The rarefaction of the air at a height might allow of a more rapid descent at first, but it would not materially affect the result.

* *Physical Review*, March, 1907.

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NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Celestial Photography with Colour-Screens.

IN his latest circular from the Flagstaff Observatory, Professor P. Lowell outlines a new method he has recently adopted for sharpening celestial photographic images, which he has applied with success to the pictures of the planet Mars, obtained during the past season. A colour-screen specially adjusted to the curve of the 24-inch objective, when certain plates were employed, has been in use for some time, but the unsteadiness of the air during the time of exposure introduced difficulty, and the present device was tried to overcome this and other drawbacks.

Various makes of plates were bathed in sensitizers, which produced extreme sensitiveness in the red region, and a special screen was used to cut off the blue and other colours, for which the focal length of the 24-inch objective was different to that for the visual region. For instance, the focus for light of λ 4600 was about 12 mm. distant from the focus for rays of λ 6000. The problem, therefore, consisted in a attempt to integrate the illumination within such limits as to give sufficient light with the least focal deviation between the different rays. The orange screen, which was made to cut off all rays more refrangible than λ 5000, was used with Cramer Instantaneous Isochromatic plates with success, and the resulting definition on the planetary detail was much sharper, although the exposure time was slightly increased. If this time can be reduced by getting plates more sensitive in the region λ 5000-6400, it is probable that much finer detail still will be photographed, and Professor Lowell hopes to have this ready for the next opposition, two years hence.—(*Lowell Observatory Bulletin*, No. 31.)

Red Stars near Nova Velorum.

Quite a considerable number of stars with interesting spectra have been detected on a series of Draper Memorial spectrum plates, taken with the 24-inch Bruce photographic telescope in Peru on June 6, 1907, with an exposure of 120 m. A list of these is given in the current *Circular*, which also announces the interesting fact that on these plates a new gaseous nebula was found, which afterwards proved to be the spectrum of Nova Velorum. Seven bright lines appear in the spectrum, having the approximate wavelengths :—

5013, 4926, 4862, 4643, 4611, 4340, and 4101.
(7) (3) (2) (4) (4) (10) (1)

The numbers in brackets are the relative intensities of the lines. All of the lines appear to coincide with bright lines in the later spectra of Nova Persei, No. 2, except that at λ 4611, which perhaps coincides with a bright line at 4608 in the spectrum of H.P. 1311. The strong helium line, 4472, however, which was bright in Nova Persei, No. 2, is absent.—(*Harvard College Observatory Circular*, No. 131, October, 1907.)

Occultation of Neptune, December 20, 1907.

Dr. Downing has furnished the following particulars for the occultation of Neptune on Friday, December 20, 1907, which was accidentally omitted from the Nautical Almanac. The phenomenon will be visible at Greenwich if the weather is favourable.

Date.	Disappearance.				Reappearance.			
	Sidereal Time.	Mean Time.	Angle from North Point.	Angle from Vertex.	Sidereal Time.	Mean Time.	Angle from North Point.	Angle from Vertex.
	H. M.	H. M.			H. M.	H M		
1907 Dec. 20	11 14	17 20	180°	1 38°	11 23	17 29	195°	153°

—(*Observatory*, Vol. XXX., p. 412, November, 1907.)

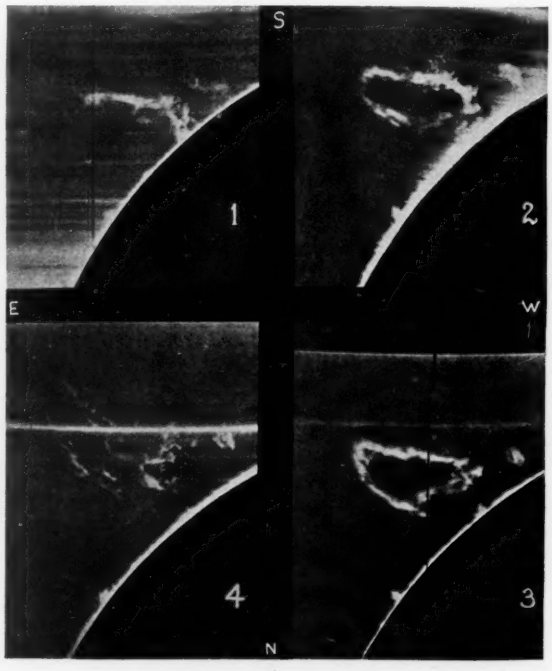
Solar Prominence Activity.

The past year has been remarkable for the prevalence of large prominence outbursts, although the spot maximum is now about three years away (1905). Mr. Philip Fox, working with the Rumford spectroheliograph attached to the 40-inch refractor at the Yerkes Observatory, obtained on May 21, a beautiful series of photographs showing the formation and decline of a gigantic prominence. These were taken in monochromatic light of calcium vapour, using the H line (near λ 3968). Thirteen photographs were obtained, but the state of the sky was not good, and only about half of these could be measured satisfactorily, particulars of the four reproduced in the figure being given below :—

	G.M.T.	Height of Prominence.
1	1907. May 21d. 4h 02m	228″·6 = 167800 km.
2	4h 52m	259″·3 = 190300 km.
3	5h 01m	280″·5 = 205800 km.
4	5h 35m	391″·6 = 287400 km.

The maximum height attained by parts of the disrupted gaseous matter was 310,700 km.

Examination of the reproduction will show clearly the various stages in the development of the prominence. Starting at position angle 138°, it was firmly rooted to the sun's disc, but the connection disappeared shortly afterwards, leaving the main body detached. It appears evident that the crest of the prominence, seen in Fig. 1, bent round to the disc, so forming the loop of Figs. 2 and 3. Careful comparison of the plates shows that the single spike of



Eruptive Prominence, May 21, 1907.

Fig. 1 coincides with the centre of the loop in Fig. 2, and, further, that on Fig. 1 there is a very faint arch south of the spike which agrees well in position with the upper arm of the loop. It seems probable, however, that the spike bowed to the south when the peak fell back. Between Figs. 2 and 3 there is also a decided change. The falling arm of the loop has descended a considerable distance and the force which a little later was to produce the long streamers of Fig. 4 was already active. During these various changes there was a perceptible movement towards the south. The two small prominences at position angles 125°.9 and 146°.9, form good points of reference in comparing the several plates.

From careful consideration of such photographs as these it is evident that it is important to provide means of obtaining photographs at shorter intervals, so that the movements of the chromospheric matter may be still more closely followed. With the Rumford spectroheliograph it is possible to make exposures on prominences around the whole disc at intervals of three minutes, and for single prominences, the exposures may follow at intervals of less than a minute.—(*Astrophysical Journal*, Vol. XXVI., p. 155, October, 1907.)

BOTANY.

By G. MASSEE.

The Fossil Flora of Tegelen-sur-Meuse.

IN 1905, Professor Dubois announced the discovery of interesting remains of plants and animals in the brick-pits of Tegelen, on the eastern frontier of the Netherlands. After the material was worked out, Dubois concluded that the deposit was of *Cromerian*, somewhat older than the Cromer Forest bed, and that the plants indicated a climate warmer than that of the last-mentioned deposit.

The plants of this very interesting deposit have recently been investigated by Clement Reid, F.R.S., and Eleanor M. Reid, B.Sc., and the result appears in *Verhand. Kon. Akad. v. Wetensch.*

Fossil seeds and leaves soon deteriorate unless preserved in some way, and the authors recommend saturating with paraffin, after which the specimens can be handled, photographed, dissected, etc. The method of extracting the seeds from the clay matrix is also given in detail. Over a thousand specimens of seeds were obtained, and from these a list of about seventy species have been determined. Compared with the flora of the Cromer Forest bed, the two deposits contain very nearly the same proportion of plants determined generically, but fewer could be recognised specifically from Tegelen than from Cromer, a fact probably due to the presence of more extinct and exotic forms at Tegelen, and these point to a somewhat warmer climate than can be accounted for by the slight difference of only 1°. The suggestion is put tentatively, that the Tegelen plant-bed may correspond with the red crag, or even with the Scaldesian. This, however, is contrary to the idea of some of the scientists in the Netherlands and Belgium, who would wish to make it Interglacial.

Cassava.

Cassava (*Manihot utilissima*) has been known for centuries as an important food plant by the natives of South America, but the resultant danger of eating the root, unless specially prepared, has much restricted its use. The danger arises from the presence of hydrocyanic acid, also known as prussic acid. Special preparation and cooking eliminates the acid, and results in a nutritious food, whereas the unpeeled, raw root may produce fatal results. Dr. C. C. Moore gives an account, in *Bulletin* No. 106 of the United States Bureau of Chemistry, of experiments made to evolve a strain of cassava so far free from poison that it may be used as food for cattle without risk. Owing to the variation in amount of the poisonous substance, sweet and bitter varieties are recognised, but the two forms appear to merge into each other, so far as the amount of hydrocyanic acid is concerned, and it appears that the amount present in the same plant at different periods, or when grown under different conditions varies considerably. According to an analysis made by the Government analyst in Trinidad, the sweet varieties average a percentage of 0.010, and the bitter 0.022. A much higher percentage has been found in the bitter variety from some localities.

About 0.04 gramme is the minimum fatal dose for a human being; therefore, if 130 grammes of the extreme bitter variety, unprepared, containing 0.03 per cent. of hydrocyanic acid, is eaten, fatal results might be expected. It is estimated that if an ox ate one kilo., a short ration for one meal, the result might be fatal.

The subject is still under consideration, but the fact was established that the hydrocyanic acid content varies in amount even in the same varieties grown under the same climatic conditions. There is also the possibility of the meal prepared for cattle-food becoming poisonous through the cyanogenetic process.

Flora of the Florida Sand Keys.

Professor Millspaugh has investigated the vegetation of the islets lying to the westward of Key West. The primary object of the survey is to enable future observers to determine what new additions have been made to each islet since 1904, also what species are able to survive under the exceptional conditions present. It is pointed out that wind transportation plays no part whatever in adding to the flora of these small wave-formed islets, and those species that succeed in establishing themselves depend on bird or water transportation. Of the twelve species that collectively constitute the most abundant and characteristic vegetation of these islets, four depend on water for their presence, and eight are conveyed by birds.

Spore Dispersal in Sphagnum.

While botanising in a swamp, Mr. E. J. Winslow was attracted by the constant repetition of a snapping sound, like the breaking of wheat straw. Investigation proved this noise to be due to the explosion of the capsules of *Sphagnum*, the sound being immediately followed by a floating cloud of reddish-brown spores, two or three inches above a cluster of capsules. This took place when the fruit had been exposed to sunshine for some time. Pinching the capsules in the fingers did not cause them to explode, but the popping continued until all the ripe capsules present on a bunch of sphagnum carried in the hand had liberated their spores. There was no breeze or other disturbance to aid in producing the explosion, but the plants were exposed to the direct rays of the sun; hence it would appear that complete dryness is the only factor necessary to cause the liberation of the spores from a ripe capsule.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Copper Mirrors.

THE old method of silvering mirrors by applying a layer of tin foil alloyed with mercury involves so much risk of poisoning the workpeople constantly breathing the mercury vapour, that numerous attempts have been made to use another metal for the purpose. It was shown by Liebig that a fine adherent deposit of metallic silver could be applied to glass by reducing a solution of a silver salt with milk sugar, and this method has been employed as a commercial process. Experiments that have been made to obtain a similar deposit of metallic copper have hitherto met with only partial success. Thus, Faraday, in 1857, showed that by dissolving copper oxide in olive oil and heating a glass plate in the solution the surface became coated with a film of copper. But the mirror thus obtained was often wanting in brilliance, and was usually disfigured by stains due to the decomposition products of the hot oil. Until recently copper mirrors had never been prepared from an aqueous solution, but it has now been found by Mr.

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F. D. Chattaway that solutions of cupric salts may be reduced by hydrazines of the aromatic series, yielding brilliant reddish films of metallic copper, the surface of which is as perfect a reflector as a silver mirror. This method of coating glass with a layer of copper will probably be extensively used in the manufacture of glass-ware for other purposes.

The Atomic Weight of Radium.

The results of determinations in 1902 upon a very small amount of a radium salt gave 225 as the atomic weight of the element. Madame Curie has now been able to repeat the determinations upon a larger amount (0.4 gramme) of radium chloride, which had been thoroughly purified by fractional crystallisation and fractional precipitation, until shown by the spectroscope to be free from all but a trace of barium chloride. The amount of silver chloride obtainable from a definite weight of the anhydrous radium salt was determined, and the atomic weights of silver (107.8) and of chlorine (35.4) being known, the corresponding equivalent of radium could be calculated. The mean of three determinations gave the atomic weight as 226.2, with a probable error not exceeding 0.5.

The Proportion of Hydrocyanic Acid in Cassava.

For centuries cassava has been used as food by the natives of South America, who press the pulped tubers into cakes which they cook to expel the hydrocyanic (prussic) acid, and store until required. Many deaths have taken place through eating the uncooked product, and the presence of the poisonous constituent has prevented cassava from being cultivated as a cattle food, for which it would otherwise be particularly suitable. The varieties of cassava may be classified into the *bitter*, containing sufficient hydrocyanic acid to be dangerous, and the *sweet*, which are usually regarded as not dangerous. Analyses made in Jamaica some years ago showed that the bitter varieties contained, on the average, 0.022 per cent. of hydrocyanic acid, whilst the sweet varieties contained about 0.01 per cent. There was no distinct line of division between the *sweet* and *bitter* varieties, the one gradually merging into the other. The varieties grown in the interior of Colombia contained only 0.001 to 0.003 per cent. of hydrocyanic acid, which accounts for the fact that the natives of that district are unaware of the existence of poisonous varieties. Mr. C. Moor has recently published the results of his experiments upon American varieties of cassava, and foreign varieties grown on American soil. The common Florida variety, known as "Florida Sweet," was found to contain 0.002 per cent. of hydrocyanic acid, and a bitter American variety, termed "White Top," yielded 0.03 per cent. It is commonly believed that all Florida varieties are harmless, and the theory that poisonous varieties grown on Florida soil become *sweet* was supported by the results of experiments at a Florida station, upon cuttings from imported poisonous stock. Thus, a variety from Jamaica, containing 0.05 per cent. of the acid, yielded only 0.018 per cent. after being grown in Florida. Conversely, cuttings of *sweet* Florida varieties doubled their percentage of hydrocyanic acid when cultivated at Biloxi, and became *bitter*. It was suggested by Mr. Camody that the difference between the *sweet* and *bitter* varieties might be due to the hydrocyanic acid being distributed throughout the whole of the tuber in the latter, while only present in the cortex of the former. Mr. Moor's experiments, however, did not support this view, for in each case he found the bulk of the acid to be present in the bark and peel, a peeled "White Top" tuber, for instance, containing only 0.002 per cent., and a peeled "Sweet Florida" tuber 0.0005 per cent. The whole of the hydrocyanic acid in cassava appears to be present in the free state, and once it has been expelled by heat no further formation of acid apparently takes place in the dried meal. Further experiments have shown that the proportion of hydrocyanic acid may undergo considerable variations during the growth of the plant, and may even disappear entirely at times, and then appear again. It is possible that long continued cultivation, under the conditions, yet to be discovered, which retard the formation of hydrocyanic acid in the plants grown in Florida, may result in the development of a variety of cassava absolutely free from hydrocyanic acid, and so quite safe for fodder without preliminary heating. Apart from this, there are numerous commercial uses for the tuber (which contains from 60 to 81 per cent. of starch, calculated on the dry substance), such as the manufacture of pastes and gums and the production of a cheap alcohol for technical purposes.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

The Horse in Europe.

IN the *South-Eastern Naturalist*, just issued, Mr. W. H. Griffin has a valuable paper on "The Antiquity of *Equus caballus* in Europe." A lower molar of the horse was found at Hayes in association with remains of the *Elephas primigenius* and *Rhinoceros antiquitatis* and with palæolithic implements, and this proved its existence in Great Britain in the early Stone age. At the time of the discovery of America, there was not even a tradition of the existence of the horse on the American Continent, although fossil remains have been found, filling up all the links in the chain of descent from the small *Eohippus* (Eocene) to the *Pliohippus*, corresponding to our *Equus*, after which the new-world species became extinct. *Equus caballus*, the true horse of our day, did not, however, according to Oscar Schmidt, ever exist before it was imported into America. In pre-glacial times, Professor E. C. Ewart states that there were in North America nine distinct species of *Equus*, and suggests that before the close of the Pliocene period American horses found their way into Asia. "Summing up the evidence," writes Mr. Griffin, "we find that *Hyracotherium* existed in Kent in the early Tertiary period; *Anchitherium* in France in the mid Tertiary; *Hipparion* and *Equus stenonis* in England in late Tertiary; and *Equus caballus* in Kent in Pleistocene times."

Rhaetic Beds of South Africa.

At the meeting of the Geological Society on November 6, a valuable paper was read by Professor A. C. Seward, on "A Collection of Fossil Plants from South Africa." The collection was made from the Molteno and Burghersdorp Beds, belonging to the Upper and Middle Karroo Formation of South Africa. New species of *Thinnfeldia* and *Baiera* were described, from the Molteno Beds, and of *Thinnfeldia*, *Odontopteris*, *Strobilites*, and *Stigmatodendron*, from the Burghersdorp Beds. Professor Seward favours the view that the Molteno Beds should be assigned to the Rhaetic period.

Glacial Beds in South Australia.

A series of Glacial Beds of Cambrian Age in South Australia was described in a paper by the Rev. Walter Howchin, F.G.S., Lecturer in the University of Adelaide, on November 20. The present extension of the beds known is 460 miles from north to south, with a maximum width of about 250 miles, in an easterly direction to the Barrier Ranges of New South Wales. The beds occur as part of a great conformable series, in the upper part of which Cambrian fossils have been found. The rocks above the Glacial Beds are mainly purple slates and limestones. The beds consists of a groundmass of unstratified, indurated mudstone, more or less gritty, carrying angular, subangular, and rounded boulders, up to 11 feet in diameter. In most sections there are more or less regularly-stratified bands. The thickness of the Glacial series has been proved up to 1,500 feet. The commonest rock-type amongst the boulders is a close-grained quartzite; but gneiss, porphyry, granite, schistaceous quartz, basic rocks, graphic granite, micaschist, and siliceous limestone occur. The discovery of ice-scratched boulders has placed the origin of the beds beyond doubt. The striæ are often as distinct and fresh-looking as those occurring in a Pleistocene boulder-clay.

Up to the present, eighty definitely-glaciated boulders have been secured, besides the known occurrence of other erratics too large for removal. A series of illustrative sections are described. It is considered probable that Mr. H. P. Woodward's suggestion, that this hardened "boulder-clay" rock had its origin from "floating ice," appears to be most in accordance with facts. The interbedded slates and limestones may possibly indicate the occurrence of inter-Glacial conditions.

More Well-Sections in Middlesex.

Mr. William Whitaker has added descriptions of 54 new well-sections in Middlesex, bringing the total described by him to 413 for the county. In the new list just published, he is joint-author with Mr. G. Burrow, F.G.S. The total is a large one for a single county. Each one represents the property of a single firm, with a few exceptions, who have thus rendered themselves independent of a water company. With underground water there seems to be little or no law, each grabbing all that is possible by the aid of experts, and every new supply privately tapped making it more expensive for the common people, who have to pay their water rate, to obtain their supply. Perhaps those who wish to nationalise the land would turn their attention to nationalisation of underground waters.

METEOROLOGY.

By W. MARRIOTT, F.R.MET.SOC.

The Rainfall of October.

VERY heavy falls of rain occurred in various parts of the country on the 16th, accompanying the passage of a deep depression from south to north. On that day 4.86 inches fell at Kingsbridge, South Devon.

An interesting article on the Rainfall of October is given in *Symons's Meteorological Magazine*. From this it appears that the North of Scotland was remarkably dry; indeed, the whole country north of the Great Glen had less than the average, and in some parts less than half the average. There was a relatively dry belt, stretching southward and eastward from Lancashire, where the rainfall was below the average at some points; and in London and its immediate neighbourhood, to the north-east, the rainfall also failed to reach the average. On the other hand, the south and east of Scotland, the greater part of England, and the south and east of Ireland, had an excess of more than fifty per cent. of rain, and there were two extensive areas—in the south of Scotland and in the south of England respectively—where more than twice the average rainfall for the month was precipitated. In those areas the fall was, in some instances, unprecedentedly great in records extending over more than thirty years.

The effect of the heavy rain on the harvest in Scotland has been disastrous, the splendid crops, which at the end of September were almost ready for cutting, having been totally lost in many parts of the country.

Winter Fogs.

During the past month thick fogs prevailed at times over a large part of the country. In London they were more than usually dense for so early in the winter. On the average, December is the month with most fogs, then comes November, January, October, and February. The conditions most favourable for fog are quiet anticyclonic weather, and an absence of wind.

Fall of "Black Rain" in Ireland.

The following account by Dr. Otto Boeddicker, in charge of the Earl of Rosse's Observatory at Birr Castle, of a remarkable fall of "black rain," is given in the Weekly Weather Report of the Meteorological Office:—

"During the night from October 8 to October 9, we had here a considerable fall (0.42 inch) of black rain. I have made fairly extended enquiries, and find that towards the south and east to south-east of Birr, it stood in black—one informant says inky—pools on the roads, yet this was not noted towards the north or west, though from these directions also I hear that rain-water tanks had to be let off on account of the blackness of the water. I heard of two cases where clothes hanging on the hedges to bleach were so thoroughly blackened by the rain as to require re-washing. This was again towards the south or south-east, three to seven miles away. Here at the Observatory, the water in the rain-gauge was so black that the observer suspected malicious interference. I procured a bottle of the water and found in it an extraordinary amount of soot. The wind during the night was S.E., and rather fresh."

Further enquiry made by the Earl of Rosse, through the medium of the *Irish Times*, has brought to light the fact that similar phenomena were observed at Clare (King's County); Mullingar (Westmeath); Stradbally (Queen's County); Rockcorry (Monaghan); and Limerick.

On October 8 and 9 a rather irregular-shaped depression was developing, with its centre over the Bristol Channel. The gradient over the south of Ireland and central or south-eastern England was for easterly or south-easterly wind, and the wind velocity corresponding with the distribution of pressure was between 12 and 15 miles per hour. The "travel" of the air would thus have been about 150 to 180 miles in 12 hours, so that there is reason to believe that the air which brought the deposit was over the central portion of Great Britain rather more than 12 hours before the "black rain" fell. It is stated that, "the meteorological evidence is not sufficient to enable us to determine whether the origin of the deposit is to be sought in Lancashire, the Midlands, or in South Wales, but it is highly probable that it came from one of these manufacturing centres."

The Climate of Cairo, Egypt.

A paper on "The Climate of Abbassia, near Cairo," by Mr. B. F. E. Keeling, has recently been issued by the Survey Department of Egypt. From this it appears that the highest temperature recorded was 117°, on August 26, 1881, and the lowest temperature was 28.4° on February 4 and 5, 1880. This shows an extreme range of 88.6°.

The mean monthly results are given in the accompanying table.

Months.	Temperature.				Relative Humidity.	Sunshine.	Rainfall.
	Mean Max.	Mean Min.	Daily Range.	Mean.			
	°	°	°	°	Per Cent.	Hours.	Ins.
January ..	64·9	44·2	20·7	54·1	68	193	·27
February ..	69·6	46·8	22·8	56·8	64	185	·16
March ..	75·6	50·0	25·6	62·4	58	233	·16
April	83·7	55·0	28·7	70·2	50	235	·08
May	90·9	60·8	30·1	76·8	46	300	·04
June	95·2	65·1	30·1	81·9	46	345	—
July	97·2	69·4	27·8	83·5	50	357	—
August ..	94·8	69·4	25·4	82 6	55	345	—
September .	90·0	66·0	24·0	78·1	61	266	—
October ..	86·0	62·8	23·2	73·2	65	246	·04
November .	75·7	54·3	21·4	65·1	66	219	·20
December .	68·4	48·2	20·2	57·9	70	172	·23
Year ..	82·6	57·6	25·0	70·2	58	3096	1·18

During the Khamsin months there are frequent oscillations in the relative humidity of great magnitude. For instance, on March 21, 1901, the mean humidity was 16 per cent., but on the following day it was 58 per cent. In the Khamsin weather some extraordinarily low relative humidities are experienced. Thus, in the above month the relative humidity remained below 15 per cent. from 9 p.m. on the 19th till 7 p.m. on the 21st, the lowest recorded being 2 per cent. This is a remarkable condition for a station on the edge of the Delta, and less than 100 miles from the sea.

During the autumn and winter morning fogs and mists

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are of frequent occurrence over the river and cultivation. In winter the characteristic wind is nearly due west. As the year advances the westerly component becomes less, until in summer and autumn the wind is almost due north. As winter approaches, the wind becomes less steady and more westerly.

Hailstorm in Cairo.

On the evening of October 21 last, a violent hailstorm occurred in Cairo. The hailstones were, on the average, about an inch in diameter, while some were as much as an inch and a half in diameter. The storm, which was preceded by lightning, only lasted a quarter of an hour. Such storms are very rare in Egypt, and consequently this one caused great excitement among the natives. The temperature at the time was 77°.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The "Osprey" Trade.

THE *Field* (November 16) gives a short account gleaned from an Australian Ornithological Journal of the havoc inflicted by a party of plume hunters in a colony of Egrets.

The visit of the recorder was made during the height of the breeding season. On his arrival at the colony, he found painfully evident traces of a recent raid in the shape of some fifty carcases of adult birds floating in the water. "These birds," he remarks, "had been ruthlessly shot while brooding their young, which latter, to the number of about a couple of hundred, had been remorselessly left to die a lingering death from hunger. Many had already succumbed. . . . Others from time to time fell from the nests to share the same fate, while others again perished from exhaustion as they sat in the nests. Perhaps the most pitiable sight of all was to watch those which had still sufficient strength to move and cry, attempting—and needless to say, attempting in vain—to attract the attention of old birds flying heedlessly by with food in their beaks."

Some day, perchance, the ghastly trophies of this raid will grace the hats of women at a church parade. For "Osprey" feathers are prized only in "civilized" countries, and among the women of "Christian" communities!

Unrecorded British Birds.

The November issue of *British Birds* has been favoured by Mr. J. B. Nichols with a list of rarities in his collection hitherto unrecorded.

Among the more remarkable we note a Black-eared Wheatear (*Saxicola caterinæ*), shot at Winchelsea on May 2, 1907; a Cetti's Warbler (*Cettia cettii*), shot at Whallington, Sussex, September, 1906; and a Nutcracker (*Nucifraga caryocatactes macrorhynchus*), shot at Broadoak, Brede, Sussex, February, 1907.

Marsh-Warbler Nesting in Surrey.

Mr. Graham Kerr sends a long account to *British Birds* for November of the breeding of the Marsh-Warbler (*Acrocephalus palustris*) in Surrey during June last. The nest was placed in the fork of a small osier, well hidden by rank herbage, and about three feet from the ground.

Occurrence of the Snow-Finch in Kent.

The second record of the Snow-Finch (*Montifringilla nivalis*) in Great Britain has just been made by Dr. N. F. Ticehurst, in *British Birds* for November. This example was shot from a flock of four or five similar looking birds on December 28, 1906.

Roller in Sussex.

Mr. J. G. Millais records in *British Birds* for November the occurrence of a Roller in St. Leonards Forest, on July 31, 1907. The bird was shot by a gamekeeper, and is now in Mr. Millais' collection.

Richard's Pipit in Norfolk.

The *Field* (November 16) contains a record of the fact that a male Richard's Pipit was shot "on the Norfolk Coast," on October 12, while a female was killed near the same spot a few days previously.

The occurrence of this bird is sufficiently infrequent to merit a record of the fact that Mr. A. H. Patterson writes to the *Zoologist* for November to say that a Richard's Pipit (*Anthus richardi*) was netted on the North Denes at Great Yarmouth on October 22.

PHYSICS.

By PROFESSOR ALFRED W. PORTER, B.Sc.

The Origin of Radium.

INVESTIGATORS are on the track of the parent substance which gives rise to radium Dr. Boltwood has found evidence that it belongs to the thorium family of elements. This is confirmed by certain experiments by Dr. Hahn, described in a communication to *Nature* (November 14). In experiments made with a new intermediate product obtained from thorium (to which he gave the name "mesothorium"), he was struck by the fact that old preparations of pure thorium contained relatively large quantities of radium. This was all the more notable because the monazite sand from which the thorium is prepared contains only a very small quantity of uranium, which is considered to be the grand-parent of radium. In the systematic tests that he has made, the older the sample the more radium is present; for example, some prepared in 1898 contained most radium of all. It is not supposed that it is the thorium itself which either directly or indirectly gives rise to the radium; but that when the thorium is precipitated it carries down with it the new substance from which radium springs. He has shown that it is not radio-thorium. Professor Boltwood had previously suggested the name "ionium," for this parent substance. This name does not meet, however, with the approval of Rutherford, who considers it is, in any case, rather premature to give names.

The Electric Waves from a Righi Oscillator.

Many attempts have been made to determine the precise character of the radiation from a source of electro-magnetic waves. Messrs. Fountain and Blake have recently applied a happy combination of theory and experiment to throw fresh light on this problem. Amongst the many conclusions which they draw from their work are the following:—

The electric waves spread out from the spark gap in such a manner that the energy at any point is approximately proportional to the square of the cosine of the angle between the line drawn from the gap to the point and the equatorial plane; and inversely proportional to the square of the distance from the gap. That it is not by any means sufficient to consider only the electric force at right angles to the direction of propagation. In light waves this is the only component present; but this is merely the consequence of the fact that such waves are observed only at many wavelengths from their source. In the case of the much longer Hertzian waves, it is possible to experiment within a fraction of a wave-length from the source, and in such a case the component which would be analogous to "longitudinal light" is present. The energy due to this component varies approximately as the square of the sine of the angle between the radius vector and the equatorial plane, and inversely as the fourth power of the distance from the spark gap. The work is described in the *Physical Review* for October.

Displacement of Spectral Lines by Pressure.

Professor Owen Richardson, in the *Philosophical Magazine* for November, develops a theory to account for the dis-

placements of the spectral lines which are produced by pressure. The theory is based on the same kind of considerations as the modern theory of the dispersion of light. Briefly stated, the theory developed attributes the displacement to the effect of sympathetic vibrations occurring in the surrounding atoms. The fact that an atom A is emitting light shows that it is surrounded by an alternating field of electric force. This alternating field will produce forced vibrations of equal period and, under certain conditions, of like phase in neighbouring atoms in the same sort of way in which a sound tuning-fork excites others of the same pitch. There will be a corresponding reaction upon the atom A; and it is shown by Professor Richardson, that the effect will be to increase the time period of the latter. The atom will, therefore, emit light which is slightly redder than if it were vibrating alone. The effect will, of course, depend upon the number of atoms crowded round; that is, it will depend upon the density of the gas.

It must be remembered that this displacement towards the red is produced only by the pressure of a gas other than the vapour of the emitting substance. Increase in the partial pressure of the vapour emitting the light generally produces a broadening of the lines; but up to the present there is no experimental evidence of a change of frequency of the original line due to this cause apart from this broadening.

ZOOLOGY.

By R. LYDEKKER.

The Natural History of the Okapi.

THE event of the month is the issue by the Administration of the Congo Free State, in Brussels, of a richly illustrated quarto memoir on the okapi, by Mr. Julien Fraipont, a naturalist whose name is well known to workers in invertebrate zoology. The illustrations comprise not only several coloured plates of the animal itself, exhibiting the diversities in marking, which have been regarded as of specific value, but likewise a number of figures of the teeth, skull, limb-bones, vertebræ, etc., so that full comparison can now be made with the skeleton of the giraffe.

A Fish New to Britain.

In the November issue of the *Annals and Magazine of Natural History*, Mr. C. T. Regan records the occurrence of the ray known as *Raia undulata* in Cornish waters. This determination is based on a specimen in the British Museum captured so long ago as 1880; it appears, however, that another Cornish example was in the possession of Crouch, by whom it was misidentified. No other instances of the occurrence of this southern species in British waters appear to be known.

Colour-change in a Wild Cat.

A few years ago, a young gibbon ape kept in the Zoological Society's Gardens changed the colour of its coat from drab to black; this change being apparently a permanant one, and not merely seasonal. An analogous change has just been observed in an African tiger-cat recently living in the menagerie, the colour-change in this instance being from bright red to dusky grey. Unfortunately, the creature died soon after its metamorphosis, so that it could not be determined whether the change was seasonal, like the exchange of the red summer dress of the roebuck for the olive garb of winter. It is, however, probable that the dusky coat would have been permanently retained. Such unexpected changes are very annoying, in one sense, to the naturalist, who may readily regard the red and the black phase as representing two distinct animals. Such a misfortune befell the present writer in the case of the tiger-cat.

Spotted Lions and Pumas.

Lions from East Africa retain more or less distinct traces of the spots of their childhood even when full grown; and it is quite evident that both lions and pumas are descended from fully spotted ancestors. By an examination of the form and arrangement of the spotting in the cubs of the two species, Mr. R. I. Pocock has been endeavouring to ascertain the nature of the markings of their respective forbears. In the case of lion cubs, the author shows that the pattern of the markings is intermediate in character between the stripes of the tiger and the rosette-like spots of the leopard, although inclining perhaps more to the former type. Another distinctly tiger-like feature in the lion cub is the presence of a white patch over the eye, which disappears in the adult. As regards the stripes of the tiger, these certainly seem to be derived from the rosettes of the leopard; the double striping frequently seen being a remnant of the rosettes. If these conclusions are correct, it is clear that lions, tigers, and leopards (and, it may be added, jaguars) form a closely allied group.

Puma cubs, on the other hand, present a pattern quite unlike that seen in any of the foregoing, and thus indicate the marked distinctness of *Felis concolor* from the lion and tiger group. Pumas may accordingly be regarded as large, uniformly-coloured derivatives of one of the groups of smaller, and probably American, cats.

The British Wild Cat.

In the November issue of the *Annals and Magazine of Natural History*, Mr. G. S. Miller separates the Scottish wild cat from its Continental representative as a distinct species, under the name of *Felis grampia*. From the Continental animal it is said to differ by its darker colour and the larger and more sharply-defined black markings; the general tone of the upper-parts being "broccoli-brown," in place of smoky grey. Such a radical change as promoting the Scottish wild cat to the rank of a distinct species is to be deplored; it is certainly not more than a race or variety of the Continental wild cat.

The Crabs of the North Pacific.

We have been favoured with a copy of a memoir on short-tailed and other crustaceans collected by the North Pacific Exploring Expedition of 1853-56, and described soon afterwards by the late Mr. W. Stimpson. The MS. and plates have been lying ever since in a Government office, and are now published by the Smithsonian Institution of Washington (*Miscell. Coll.* Vol. XLIX.) practically as left by the author. This opportunity may be taken of acknowledging the receipt of a copy of a paper by Mr. J. P. Bovard, published by the University of California, on the large single-celled organism known as *Condylostoma patens*.

Papers Read.

At the first evening meeting of the Zoological Society for the Session 1907-8, held on November 12, Mr. R. Lydekker exhibited the skulls and horns of the takin, or gnu-antelope, of Bhutan, which is racially distinct from the typical *Budorcas taxicolor* of the Mishmi Hills. It is characterised by its much smaller horns. He also described a leopard skin from Uganda, remarkable for its short limbs and tail and the jaguar-like character of its spots. Mr. E. S. Goodrich read a paper on the scales of fishes. Messrs. Oldfield Thomas and R. C. Wroughton continued their account of the Rudd exploration of South Africa, giving a list of mammals obtained from Beira. Dr. P. Chalmers Mitchell and Mr. R. I. Pocock contributed notes on the feeding of serpents in captivity. Mr. C. T. Regan gave descriptions of new loricariid fishes from South America. Lt.-Col. N. Manders furnished notes on Mayer's pigeon; while Mr. F. E. Beddard directed attention to some points in the structure of the Malagasy mongoose, *Galidictis striata*.

XUM

REVIEWS OF BOOKS.

ARCHÆOLOGY.

The Paradise of the Fathers, compiled by Athanasius Archbishop of Alexandria; Palladius Bishop of Helenopolis; St. Jerome, and others. Translated from the Syriac by Ernest A. Wallis Budge. (London: Chatto and Windus; 15s.).—A priceless boon has been conferred upon English readers by Mr. Wallis Budge in his translation from the Syriac of the "Paradise of Palladius." The book is, in fact, a history of Egyptian Monasticism in the first centuries of the Christian era, and, apart from its curious and unique interest as the record of a phase of human endeavour, its interest cannot be over-rated whether it is studied from the religious, historical, or archæological standpoint. The manuscripts from which the translations were made, and to which Mr. Budge obtained access, through the kindness of the Vicar of the Chaldean Patriach at Nineveh, dated from the thirteenth or fourteenth century, and included copies of the Syriac versions of the work of Palladius, which were made by the Monk Rabban Anan-Isho, in the seventh century. He found the manuscripts to contain, among others of great interest and value, the Life of St. Anthony, by Athanasius; The Book of Paradise of Palladius; and the histories of the Solitaries of the Desert of Egypt, attributed to St. Jerome. Of these, the most interesting is the Book of Paradise of Palladius. He embraced the ascetic life during the fourth century, and spent some years in visiting the Monastries in the neighbourhood of Alexandria, making the acquaintance of about "two thousand of the great and strenuous men who lived in them," including that of two famous monks who had been the personal friends of St. Anthony. Later on, in 420, he wrote the biographies of the monks and called it "Paradise," to signify the spiritual garden in which the flowers were the lives of the Holy Fathers. This work was undertaken at the request of his patron, Lausus, an official of high rank, supposed to have been a chamberlain of the Emperor Theodosius II. It was also dedicated to him, and has hence been known as "The Lausiac History of Palladius." The education and spiritual training held necessary to fit a man for the monastic life in the fourth century were such as to deter all but the most zealous seekers after personal holiness. Palladius, for example, first spent three years with "the blessed priest, Innocent," on the Mount of Olives. He then visited Isidore, of Alexandria, a wealthy man, who devoted all his means to the poor and lived a life of strict ascetism. "He never partook of a full meal, seated comfortably at a table, and never washed." But Palladius, feeling that this *régime* was insufficient to subdue his passions, went into the desert to sojourn with the Anchorite Dorotheos, who had lived in a cave for sixty years. This holy man had been the friend of St. Anthony. He lived on six ounces of bread, a little water, and a small bundle of green herbs a day, which he earned by the sale of palm-leaf baskets that he made during the night. The days he spent in collecting stones to build cells for the monks who could not do so for themselves. But under this severe test of endurance Palladius broke down, and was obliged to return to his friend Isidore. It was after this that he spent three years in visiting the monks of the Desert of Upper Egypt. His health again breaking down he was advised by the physicians of Alexandria to visit Palestine. While there he learned to know St. Jerome, and the famous Melania the Great, a woman of wealth and position, the widow of a Roman official, who ministered to the wants of the Fathers. He was ordained Bishop of Helenopolis, and subsequently became involved in the persecution of John Chrysostom, Bishop of Constantinople. The manner of life led by Isidore and Dorotheos, is, with individual variations, typical of that of the Egyptian Fathers. Some of them, as that of the Virgin Maryânâ, are of singular beauty, some, as that of the grass-eating Monk, merely droll, nearly all touching and significant. With the passage of the centuries, mankind slowly approximates to the ideal of conduct called Christianity. The Egyptian monks sought to attain personal holiness through escaping from the bonds of the flesh by a rigid self-abnegation. To a man, the eye of whose soul is fixed fervently on one idea, it is difficult to see things in proportion. That there were examples of folly and failure among them was inevitable. Thus the blessed priest Innocent was of so merciful a disposition that he stole from the brethren to give to the poor—a man "lacking in sense," says the clear-sighted Palladius. The great St. Jerome was so beset by the vices of "envy and evil-eyedness" that none of the holy men would live in his neighbourhood. Of Heronion and Bosphoria, it is recorded to their credit that "they had such a firm hope in the happiness which was to come that they neglected even their children." The Holy Macarius could not endure that any should surpass him in ascetic rigours, and ate no cooked food for seven years, because he had heard that certain monks had abstained from it during Lent. Yet it is impossible to read the record of their lives with an unbiassed mind without feeling that in the main these men in whose souls "the sea of Faith was at the full" did attain their ideal of personal holiness. Not only were they in their obscurity a guiding light, a beacon in their own age, but they became the spiritual fathers of that Western Monasticism, which kept alive the seeds of learning and religion to blossom into a fuller life at the Renaissance and the Reformation.

ANTHROPOLOGY.

The Native Races of the British Empire: Natives of British North America—I., The Far West, the Home of the Salish and Déné, by C. Hill-Tout (London: Archibald Constable and Co., Ltd., 1907; pp. xiv. and 263; illustrated; price 6s. net).—The rapidity with which the volumes of this excellent series follow one another reflects the greatest credit on the editor and publisher, and cannot fail to be highly satisfactory to the (we hope) numerous subscribers. The author of the one now before us dates his preface from Abbotsford, British Columbia, and may therefore be presumed to be well acquainted with the manners and customs of the tribes of whom he writes, as, indeed, is self-evident from the text. The number of Indian tribes inhabiting British America is so great that it has been found advisable to make their description extend to two volumes. In the present volume Mr. Hill-Tout discusses only two linguistic groups, which he calls the Déné and the Salish; the latter occupying only a small tract of territory in comparison with that held by the former. Although Déné may be the term generally used in British Columbia, we think the author would have been better advised had he employed the well-known term, Athapascan (or Athabascan) for the first group, as the name Déné is not even mentioned in Professor Keane's volumes in the Cambridge Geographical Series, which so many anthropologists use as text-books. Great interest attaches to the Salish stock (as represented by Flat-heads and Shuswaps), on account of its being, according to the writer last mentioned, a direct derivative from the Eskimo. We should have liked to have heard more from the author with regard to the reputed Mongolian origin of American Indians, but as he refers to "Mongoloid features" in the subjects of some of the photographs, it may be presumed that he is an adherent of the theory. While writing in a thoroughly popular style, the author gives his descriptions in a manner which cannot fail to be of interest to the professed ethnologist; and his selection of photographs is on the whole admirable.

ASTRONOMY.

Astronomical Essays, by J. Ellard Gore, F.R.A.S., etc. (London: Chatto and Windus, 1907; pp. ix. and 342, with 6 illustrations; 6s.).—Of the two dozen essays of various lengths and on various subjects which compose the present volume, six have already appeared in the pages of "KNOWLEDGE & SCIENTIFIC NEWS," and three others in those of the *Observatory*. Judged by its length, the most important of them is on Sir William Herschel's astronomical theories and observations, which occupies nearly one-fourth of the book, but is rather lacking in some of the qualities expected in an "essay," though quite admirable as a summary or digest. In another essay, on Michell's astronomical views, we are inclined to think that the author,

in his eagerness to champion a generally underrated man, has not scrupled to exaggerate his case. We cannot agree with any subtraction from Herschel's glory for the sake of Michell. The first few chapters or essays deal with ancient astronomy, and others of the hitherto unpublished essays are on such varied subjects as "The Names of the Stars," "The Evolution of Astronomical Instruments," "The Brightness of the Sun," "The Size of Stellar Systems," "The Magellanic Clouds," and "The Ringed Planet." Of those that have appeared before, perhaps the one of most general interest is the much quoted "Possible Celestial Catastrophe." There is, however, much to attract the attention of the astronomical reader, though, as is only to be expected, the interest is unequally sustained. Mr. Gore's views on most astronomical subjects are well-considered, and always worthy of attention.

NATURAL HISTORY.

A Hunter's Wanderings in South Africa, by F. C. Selous. (London: Macmillan and Co., 1907).—This book contains the story of a mighty hunter, told with all modesty, yet with a verve that makes it fascinating reading—fascinating, yet at times pathetic. Mr. Selous hunted in the golden days, when big-game swarmed over the land, but since then, and it is not so long ago—less than forty years—rinderpest, the inroads of "civilization," and war have wrought red ruin upon the land, at any rate from the naturalist's point of view. The troops of elephants have now become so sadly thinned as to need the strong arm of the law to protect them, the white rhinoceros has gone for ever, the white-tailed gnu is practically extinct. And this work of destruction, it is to be feared, is steadily going on, at any rate in areas outside British rule, while the fact that no restriction is put upon the use of fire-arms by the natives contributes still further to the slaughter. A heavy toll is still levied upon elephants for the sake of their ivory, the work of destruction being carried out by natives at the instigation of Europeans engaged in the ivory traffic. White men may shoot only a limited number, and for this concession a very heavy licence must be paid. Thus the markets must be supplied by animals killed by the blacks, they being privileged to kill as many as they can. Mr. Selous was no feather-bed hunter, and more than once the scythe of death has touched him. He has been in perils from the natives and perils from the beasts he hunted, in perils of drowning and in perils of fever; yet through all he has come out sound and well, and will doubtless give to the world yet other volumes to stir the blood of those who love to go where danger lurks; or even of those who prefer to set their pulses beating by the fireside. It is a book that will appeal to a very wide circle of readers, the sportsman, the naturalist, the traveller, and the anthropologist, all alike will turn to its pages with profit.

The Romance of Animal Arts and Crafts, by H. Coupin D.Sc., and John Lea, B.A. (London: Seeley and Co., 1907). —The only original feature about this book is its title, inasmuch as it covers the same ground as, and has apparently been inspired by, the Rev. J. G. Wood's "Homes Without Hands," and Houssay's "Industries of Animals." It is, however, a pleasantly-written book, and the illustrations are fairly good.

PHOTOGRAPHY.

The Year Book of Photography. Edited by F. J. Mortimer, F.R.P.S. (London: The *Photographic News*; Price 1s.).—The forty-eighth issue of this well-known annual is very different from what it used to be a generation ago. It is improved in many details when compared even with last year's volume. The formulæ are better arranged, it has a really useful index, and one section at least is easily turned up, as it is provided with a thumb-notch. If the method of notching the margins were extended, and the indexes put together immediately after the front cover, or so arranged that they could be turned to in a moment instead of having to be sorted out from among the advertisements, the usefulness of the book would be very much increased. By far the chief value of such a volume consists in the formulæ, tables, and lists, and these are well selected, judiciously condensed, and conveniently arranged. They give information that the practical photographer really wants. We do not know why, but it seems to be considered necessary to add to these a readable section. This year there are articles on seascape, landscape, portrait, architectural, and flower photography, by authors who are well-known experts in the subjects of which they treat. We would suggest that the titles of such special articles might be printed on the back of the cover, for they have no more connection with one year than another. Then they would not be altogether lost when the volume passes in its natural course from the table to the bookshelves.

BOOKS RECEIVED.

The Power of Concentration. By EUSTACE MILES, M.A. (London: Methuen & Co., 1907, pp. 196, 3s. 6d. net.)

Pitman's Year Book and Diary for 1908. (London: Sir Isaac Pitman & Sons, pp. 193 and Diary, 1s.)

The New Ethics. By J. HOWARD MOORE. (London: Geo. Bell & Sons, 1907, pp. 216, 3s. net.)

The Conquest of Cancer. By C. W. SALEEBY, M.D. (London: Chapman & Hall, Ltd., 1907, pp. 397, 7s. 6d. net.)

Types of English Literature. By F. W. Chandler. (London: A. Constable & Co., Ltd., 1907, pp. 584, 2 vols., 12s. net.)

Science of Nature-History. By N. J. READYMONEY. (London: "Times of India," 1907, pp. 103, 4s.)

Standard Time Dials. — Professor R. A. Gregory has designed, and Messrs. George Philip and Son publish, an ingenious contrivance for showing the relation between longitude and time all over the world. The apparatus consists of a stout wooden board, with a clock-face divided into twenty-four hours, numbered 1 to 12 a.m., and 1 to 12 p.m. Within the circles formed by the numerals are rotating discs, one bearing a coloured map of the Northern, the other of the Southern Hemisphere. If the Greenwich meridian on these maps (on which the meridians radiate like spokes) is set to noon, then the standard time at any place is indicated by the hour to which the meridian passing through the place points. It is a serviceable arrangement both for educational and for reference purposes.

A "Day by Day" Model. — A useful contrivance for exhibiting to classes of children the orbit of the earth about the sun, the changing seasons, and the lengthening or shortening day, has been constructed by Messrs. George Philip and Son. The model, which can be supported against a wall, instead of requiring a horizontal position, is not unlike a clock-face with days marked instead of minutes, and months instead of hours. The earth joined to the sun by a radial arm is a small 6-inch terrestrial globe, with the pole tilted at $23\frac{1}{2}^{\circ}$. As the radial arm and the globe travel round the yellow sphere representing the sun, a small counterpoise continually maintains the earth's sphere at its proper angle of inclination. The continents, oceans, degrees of longitude and latitude, all being marked, the passage of the seasons and the length of the day are all indicated.

Waterman's Fountain Pens — The ideal fountain pen is one that will write when it is wanted, and will not distribute ink that is not wanted at inconvenient moments. If to these accomplishments can be added the passive one of being easily filled, no more can be asked of a pen. A fairly exhaustive series of experiments with Waterman's Fountain Pens appear to warrant the belief that they are thoroughly trustworthy in all these particulars; and a device as simple as it is ingenious, consisting of a series of spoon-shaped cells on either side of the canal which feeds the ink to the nib, is quite efficacious in preventing those sudden and disconcerting flows of ink which result in blotting and inkiness. The chief feature of the Waterman Pen is its regularity of flow.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Preparation of Microscopical Objects.

(*Continued from page* 264.)

I have never seen any mechanical feed on the Yung-Thoma microtome, and the carrier has a tendency to jump slightly when hard or large sections have to be cut, but this form of instrument has done excellent work in its day, and is still to be seen in many of our laboratories.

The more recent types of microtomes, whilst retaining the principle of knife-block and slides as previously described, are modified in that the object moves in bearings at right angles to the travel of the knife, the necessary delicacy of motion being obtained by having a very fine micrometer screw to feed the object-carrier. This lends itself to many devices for automatic feed, by which each return of the knife is made to actuate a ratchet and pawl movement, and so to raise the object a definite distance each time, the distance being capable of pre-adjustment within quite wide limits. In most cases, also, a mechanical movement can be given to the knife. This type of microtome is exceedingly efficient and cuts sections under varying conditions with great regularity. So fine a micrometer screw has, however, a tendency to wear, and the bearings of the carrier may also wear. It might be thought that the overhanging knife, supported as it is on one side only, would be liable to spring somewhat, but the weight of both carrying-block and knife almost entirely obviates this in practice. To most of these instruments modifications are fitted, by means of which sections can be cut when embedded in celloidin, or to enable them to be frozen in ether, ethyl-chloride, or carbon dioxide gas. Such microtomes with many individual and ingenious modifications of one sort or another are made by Schanze, Leitz, Reichert, Bausch and Lomb, and other makers.

R. and J. Beck make a microtome on somewhat similar principles, designed by Professor Delépine, in which the knife runs on two slides set one on each side of the object, but I do not think it has come into such general use, and it is, I believe, primarily designed for frozen sections. Bausch and Lomb make a somewhat similar type in which the *object* moves on two such slides.

Frequently only a few sections from an object are required, but in many cases it is necessary to take a series of sections right through, so that the whole can be examined systematically. For instance, if one is studying the development of an early embryo it is necessary to have complete sections through the embryo from one side to the other, losing none and having all in orderly sequence, and such sections may easily run, like some in my possession, to 800 or 1,000 distinct sections. These are known as "serial sections," and though such a series can with skill and care be cut in the microtomes above described, it is much easier, as well as safer, to cut them in microtomes specially designed for the purpose. The "Cambridge Rocking Microtome," made by the Cambridge Scientific Instrument Company, cuts such sections with great facility, and it is, I am glad to say, of English manufacture and very moderate price. It is found in nearly all our English laboratories. A somewhat similar microtome, known as Leake's, is made by Messrs. Pye, also of Cambridge. The fault of the "Cambridge Rocking Microtome" is that the rocking motion gives sections which are not exactly parallel, though I must say that I have myself never found this a drawback, but a more costly form has been designed which obviates this defect.

Another well-known serial-cutting microtome is the Minot, which is much used abroad and in America. It is worth noting that in all these types of serial instruments, unlike those formerly described, it is the object which moves and the knife which is fixed.

The "Cambridge Rocking Microtome" requires only a simple razor—the other types require heavy knives of various shapes, all somewhat costly, and by no means easy to sharpen. I shall try to give a few hints on this point before I finish my suggestions on section-cutting, but I may say here that the knives are generally supplied with thin hollow-ground edges for celloidin embedded objects, with less thin and less hollow-ground edges for paraffin, and with strong, straight edges for frozen sections.

This brings me to the next point—as to the respective merits of celloidin, paraffin, and freezing methods for sections.

The advantages of the *freezing method* are that the tissues do not require long or careful preparation beforehand, and, therefore, that it can be utilised at short notice. The object is frozen to give it the necessary consistency and firmness to enable it to be cut by the knife whilst retaining its parts in due position. Ether, ethyl chloride, or carbon dioxide gas can be used as the medium which, by its evaporation, will produce the necessary amount of cold. Ether is the most frequently used, and for this a simple and inexpensive microtome like the Cathcart does very well, but the fine orifice of the ether tube is rather apt to become blocked. Ethyl chloride used as a spray is convenient but expensive, and it is not easy to keep the tissues at the right degree of freezing. The best medium of all is carbon dioxide in cylinders, and microtomes are made now to screw on to such cylinders. The initial cost is somewhat great, and the cylinders are, of course, far from portable, but the cost of compressed carbon dioxide is less than that of pure ether.

(*To be continued.*)

Royal Microscopical Society.

October 16.—Dr. J. W. H. Eyre, Vice-President, in the chair. A Warington microscope, formerly belonging to Dr. W. B. Carpenter, and illustrated in the first edition of "The Microscope and its Revelations," was presented by Mr. J. E. Ingpen. Dr. Hebb exhibited bacterial and histological slides to illustrate clinical routine work in a hospital. Mr. Taverner showed a number of stereo-photomicrographs of water-mites, taken with a stop behind the objective, as described before a previous meeting. These were taken in their natural colours by the Sanger-Shepherd process, and were most admirably executed. Mr. Rousselet exhibited a pair of cutting forceps made by Mr. Curties, and a pair of forceps-scissors by Mr. Traviss, for cutting and holding pond-weed, etc. Dr. Hebb read a paper by Mr. A. A. C. Eliot Merlin on "Ghost Images in the Secondaries of *Coscinodiscus asteromphalus*, with some Remarks on the Highest Useful Ratio of Magnify-

ing Power to Aperture." In an experiment suggested by some remarks of Mr. Nelson, the author was able to distinguish perfectly well-defined ghost images of the condenser stop in many of the cap perforations of this diatom, using a 3 mm. apochromat of N.A. 1.4, a 40 ocular, and a Powell's dry apochromatic sub-stage condenser. The exact size of the perforations was measured and found to be $\frac{1}{83800}$ inch. The author favoured the use of high eye-pieces in many cases, especially the 40 ocular. Mr. Beck thought there was little advantage in using high oculars with low-power objectives, the advantage of high oculars only beginning with lenses of high-power and maximum aperture. Mr. J. W. Gordon said there was an advantage in high magnifying power in the case of objects like diatoms, where there were various structures lying close together, one beneath the other, which it was of importance to be able to separate sufficiently in the eye for one set of markings to be distinctly visible while the others were clear of the sensitive region of the eye. This, Mr. Gordon showed, resulted from an increase of magnifying power. Dr. Hebb read a further paper by Mr. Merlin on "A New Prismatic Ocular," designed with the help of Mr. Nelson and constructed by Zeiss, to obviate the great fatigue entailed by prolonged observations with an upright microscope. The eyepiece has proved most efficient. A paper by Mr. Alfred Letherby on "Systematic Exposure with Transmitted Light in Photomicrography" was taken as read. Mr. Nelson contributed a note on Mr. Conrady's new $\frac{1}{8}$ inch objective, referred to in these columns last month.

Quekett Microscopical Club.

October 18.—Mr. W. R. Traviss exhibited and described three small pieces of apparatus designed for cutting and holding small pieces of weed, etc., required for examination from the micro-aquarium, bottles, or test tubes. Mr. C. F. Rousselet, F.R.M.S., described a form of cutting forceps designed for the same object and issued by Messrs. Baker. Mr. H. Taverner, F.R.M.S., exhibited a number of stereo-photomicrographs of water-mites done by the Sanger-Shepherd transparency process. A note by Mr. G. P. Deeley on "Three Water-mites New to Britain" was read. These were *Thyopsis cancellata*, Protz; *Sperchon glandulosus*, Koen; *Lyania bipapillata*, Sig. Thor. Some notes on "Secondary Markings in *Navicula Smithii* and *N. crabro*," by Mr. A. A. C. Eliot Merlin, F.R.M.S., were read by the Hon. Secretary. The Hon. Editor, Mr. E. P. Smith, gave a résumé, prefaced by a few remarks of his own on the subject, of a valuable paper on "British and Foreign Pseudo Scorpions," contributed by Mr. Edv. Ellingsen, of Kragerö, Norway.

Two New Microscopes.

I have recently had an opportunity of inspecting two new microscopes made by Messrs. J. Swift and Son, which embody several interesting modifications. This firm are the makers of the well-known petrological microscope designed by Mr. Allan Dick, the main feature of which is the simultaneous rotation of analyser and polariser. This model has been modified by Dr. J. S. Flett, of the Geological Survey and Museum, as follows:—The substage is of the rack and pinion type, with centring movements. Beneath the sub-stage ring is carried the polariser, removable as desired, and above the ring, but mounted independently of the polariser, is a triple nose-piece carrying two interchangeable condensers, a low-powered and a high-powered one for their respective work. There is an iris diaphragm and the usual carrier for stops, which takes also selenites and quarter undulation mica plates, all of which can be rotated when in position. The main tube of the microscope carries two Bertrand lenses. The analyser is placed above the ocular and is readily swung aside. Both it and the polariser are graduated, and the former is fitted with a vernier and a small reading microscope to enable the most delicate measurements to be taken. The whole microscope is most carefully made and finished, and is certainly the most elaborate petrological microscope made. It is, however, owing to its long tube and elaborate sub-stage fittings, somewhat high from the table.

The other microscope is a Bacteriological instrument made for Professor Starkey, which contains a new mechanical stage working flush on the top of the stage, and giving a transverse movement of more than three inches, the whole of which can, of course, be utilised when the condenser is racked right up, and without any possibility of fouling the condenser mount, with its resultant annoyance of decentring, etc. The amount of travel is quite unusual, and the motion is transmitted by worm and pinion, and not by friction wheels. The sub-stage contains focussing and centring adjustments of a light and yet steady type, and the condenser can be thrown out of the optic axis when required. The fine adjustment is Messrs. Swift's well-known "Ariston" type with levers of the double order working beneath the milled head.

The Use of the Microscope.

I have received two excellent little booklets which mark a new departure, and an admirable one, on the part of two leading makers of microscopes. They are endeavours to provide purchasers of microscopes with simple and elementary instructions for the use and preservation of their instruments, without intending to compete with the ordinary books on the subject. The first is a neat little book by W. Watson and Sons, containing 24 pages, and is entitled "The Book of the Watson Microscope." It contains a drawing of two of their microscopes with each part clearly named, brief but explicit instructions on how to set up a microscope for use, how to use the objectives and adjust the condenser, how to obtain dark-ground illumination, etc. Notes follow on objectives, magnification, flatness of field, resolving power, correction for cover-glass and tube-length, and some general hints. The other booklet is issued by Messrs. Bausch and Lomb, and consists of 36 pages, entitled the "Use and Care of the Microscope," extracted from Edward Bausch's well-known little book on the "Manipulation of the Microscope." It covers similar ground to Messrs. Watson's book, and is not less clear and practical, though somewhat differently arranged. Messrs. A. E. Staley and Co., of 19, Thavies Inn, E.C., are the London agents of Bausch and Lomb, and they offer to send a copy of their little booklet to anyone of my readers who cares to apply for it, enclosing a stamp for postage.

Messrs. Bausch and Lomb also send particulars of new models of microscopes, in which we observe the continued triumph of the English lever form of fine adjustment over the Continental direct-acting micrometer screw type, combined with a handle bar for lifting the instrument. One of the models contains a new form of swing-out condenser of ingenious design. There is also a new microtome with rigid knife and horizontally-travelling object carriage on the Minot principle.

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge, Correspondents are requested not to send specimens to be named.]

XUM

The Face of the Sky for December.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 7.45 and sets at 3.54; on the 31st he rises at 8.9 and sets at 3.58. The equation of time on the 25th and 26th is only 15 seconds, and for ordinary purposes is negligible.

Winter commences on the 22nd, when the Sun enters the sign of Capricorn at 11.52 p.m.

Sunspots are fairly frequent and may usually be observed on the Solar disc, although it is considerably past the time of maximum.

The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given below :—

Date.	Axis inclined from N. point.	Centre of Disc N. or S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Dec. 2 ..	15° 59′E	0° 40′ N.	35° 36′
,, 12 ..	11° 49′E	0° 37′ S.	263° 50′
,, 22 ..	7° 13′E	1° 52′ S.	132° 5′
Jan. 1 ..	2° 23′E	3° 5′ S.	0° 22′

THE MOON :—

Date.	Phases.	H. M.
Dec. 5 ..	● New Moon	10 22 a.m.
,, 12 ..	☽ First Quarter	2 16 a.m.
,, 19 ..	○ Full Moon	5 55 p.m.
,, 27 ..	☾ Last Quarter	11 11 p.m.
,, 7 ..	Perigee	2 42 a.m.
,, 22 ..	Apogee	9 44 p.m.

OCCULTATIONS.—The following table gives particulars of the principal occultations visible at Greenwich :—

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N point.	Reappearance. Mean Time.	Reappearance. Angle from N. point.	Moon's Age.
			p. m.		p. m.		d. h.
Dec. 12	30 Piscium ..	4·7	3 35	23°	4 28	285°	7 6
,, 12	33 Piscium ..	4·6	5 28	51°	6 42	249°	7 8
,, 13	20 Ceti ..	4·9	3 57	110°	4 44	194°	8 6
,, 15	ξ^2 Ceti ..	4·3	2 55	93°	3 47	219°	10 5
			a. m.		a. m.		
,, 18	δ^1 Tauri ..	3·9	0 53	147°	1 18	185°	12 15
,, 18	δ^2 Tauri ..	4·2	2 9	77°	3 18	262°	12 16

THE PLANETS.—Mercury (Dec. 1, R.A. $15^h\ 5^m$; Dec. S. 14° 54′. Dec. 31, R.A. $18^h\ 2^m$; Dec. S. 24° 28′) is a morning star in Libra and Scorpio. The planet is at greatest Westerly elongation of 20° 20′ on the 1st, when he rises at 5.42 a.m., or two hours in advance of the Sun.

Venus (Dec. 1, R.A. $17^h\ 50^m$; Dec. S. 24° 25′. Dec. 31, R.A. $20^h\ 32^m$; Dec. S. 20° 38′) is an evening star in Sagittarius, setting $1^h\ 35^m$ after the Sun on the 15th. In the telescope the planet appears gibbous, 0·9 of the disc being illuminated. The apparent diameter of the planet is increasing, being now about 11″.

Mars (Dec. 1, R.A. $22^h\ 16^m$; Dec. S. 12° 6′. Dec. 31, R.A. $23^h\ 33^m$; Dec. S. 3° 28′), although diminishing in brightness in consequence of increased distance from the earth, is with his ruddy colour a fairly conspicuous object in the evening sky, being due South shortly after 5 p.m. at an altitude of 30° above the horizon. The apparent diameter of the planet has diminished to 7″·6, and although the planet is well placed for observation his surface markings are now difficult for small telescopes. On the 15th the planet sets at 10.44 p.m. The planet is in conjunction with Saturn on the evening of the 31st, Mars being 1° 50′ N.

Jupiter (Dec. 1, R.A. $9^h\ 5^m$; Dec. N. 17° 19′. Dec. 31, R.A. $8^h\ 59^m$; Dec. N. 17° 50′) rises on the 1st at 8.50 p.m. and on the 31st at 6.43 p.m., and is the most conspicuous object in the late evening sky looking East. The planet is stationary on the 1st, after which he is describing a retrograde path in Cancer, several degrees S.E. of Castor and Pollux. The equatorial diameter of the planet is 42″ on the 15th, whilst the Polar diameter is 2″·7 smaller. This flattening is noticeable even in small telescopes.

The following table gives the satellite phenomena visible in this country before midnight :—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.
Dec.			
6	II.	Tr. E.	9 40
10	I.	Sh. I.	9 25
	III.	Sh. E.	9 56
	I.	Tr. I.	10 27
	III.	Tr. I.	10 28
	I.	Sh. E.	11 45
11	I.	Oc. R.	9 56
Dec.			
13	II.	Tr. I.	9 6
	II.	Sh. E.	10 4
17	III.	Sh. I.	10 14
	IV.	Tr. I.	10 48
	I.	Sh. I.	11 19
19	I.	Tr. E.	9 2
20	II.	Sh. I.	9 41
	II.	Tr. I.	11 27
Dec.			
22	II.	Oc. R.	9 27
25	I.	Ec. D.	10 23
	IV.	Ec. D.	11 37
26	I.	Tr. I.	8 28
	I.	Sh. E.	10 1
	I.	Tr. E.	10 48
28	III.	Oc. R.	10 43
29	II.	Oc. R.	11 46

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse.

Saturn (Dec. 1, R.A. $23^h\ 20^m$; Dec. S. 5° 47′. Dec. 31, R.A. $23^h\ 34^m$; Dec. S. 5° 15′) is a conspicuous object in the evening sky, being due South about 6 p.m. near the middle of the month. The planet is situated in Pisces and appears in the sky several degrees South of the great square of Pegasus; he is readily distinguished by his brightness and *leaden* lustre. The ring appears closed, and is represented by a luminous line protruding from each side of the ball.

Uranus (Dec. 15, R.A. $18^h\ 51^m$; Dec. S. 23° 18′) is approaching conjunction with the Sun, and hence is unobservable.

Neptune (Dec. 15, R.A. $7^h\ 1^m$; Dec. N. 21° 52′) rises about 5.30 p.m. near the middle of the month, and is due South about 1 30 a.m. The planet is situated in Gemini, about 1½° N.W. of ζ Geminorum, but in small telescopes without setting circles it is difficult to identify from the numerous small stars in the same field of view. He may, however, be detected by his motion if observations are made on several successive nights.

METEORS.—The principal shower of meteors during the month is the Geminids, Dec. 10th to 12th; the radiant is near Castor, in R.A. VII^h 12^m, Dec. + 33°. The meteors are short and quick, and difficult to record accurately.

VARIABLE STARS.—Minima of Algol may be observed on the 7th at 11.44 p.m., 10th at 8.33 p.m., 13th at 5.22 p.m., and the 30th at 10.16 p.m.

o Ceti (*Mira*) was fairly bright near its maximum on the 15th of last month, but observations should be continued as the period is uncertain.

TELESCOPIC OBJECTS :—

Double Stars.—1 Pegasi $21^h\ 17{\cdot}5^m$, N. 19° 20′, mags. 4·5, 8·6; separation 36″ 2.

π Andromedæ $0^h\ 31{\cdot}5^m$, N. 33° 11′, mags. 4·0, 8·0; separation 36″·3.

α Piscium $1^h\ 56{\cdot}9^m$, N. 2° 17′, mags. 3·7, 4·7; separation 3″·6.

ι Trianguli $2^h\ 6{\cdot}6^m$, N. 29° 50′, mags. 5, 6·4; separation 3″·5.

Clusters.—(☿ VI. 33, 34.) The Perseus clusters visible to naked eye and situated about midway between γ Persei and δ Cassiopeiæ. These magnificent clusters are described by Smyth as "affording together one of the most brilliant telescopic objects in the heavens."

(M. 34.) A mass of small stars about the 8th magnitude; not very compact. The cluster is just perceptible to the naked eye about 5° N.W. of Algol.

XUM